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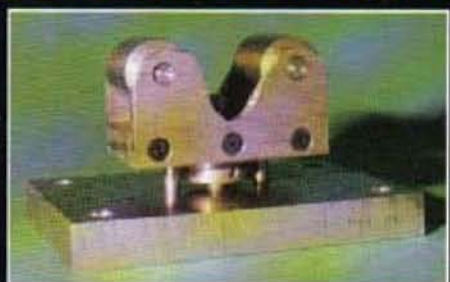
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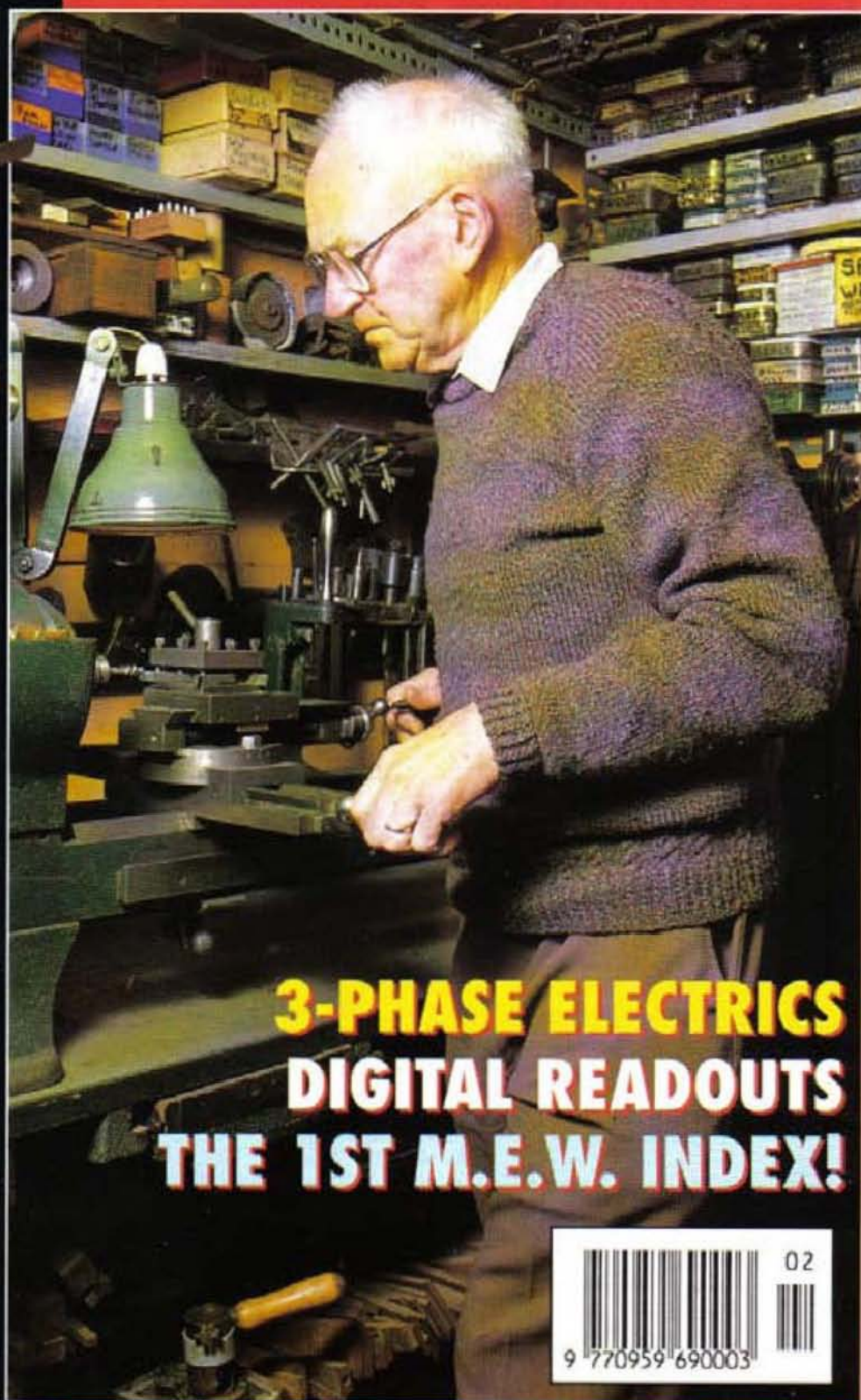
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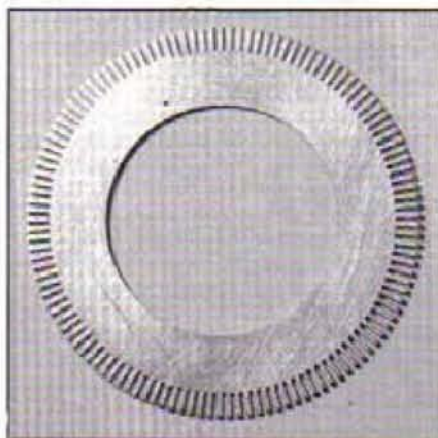
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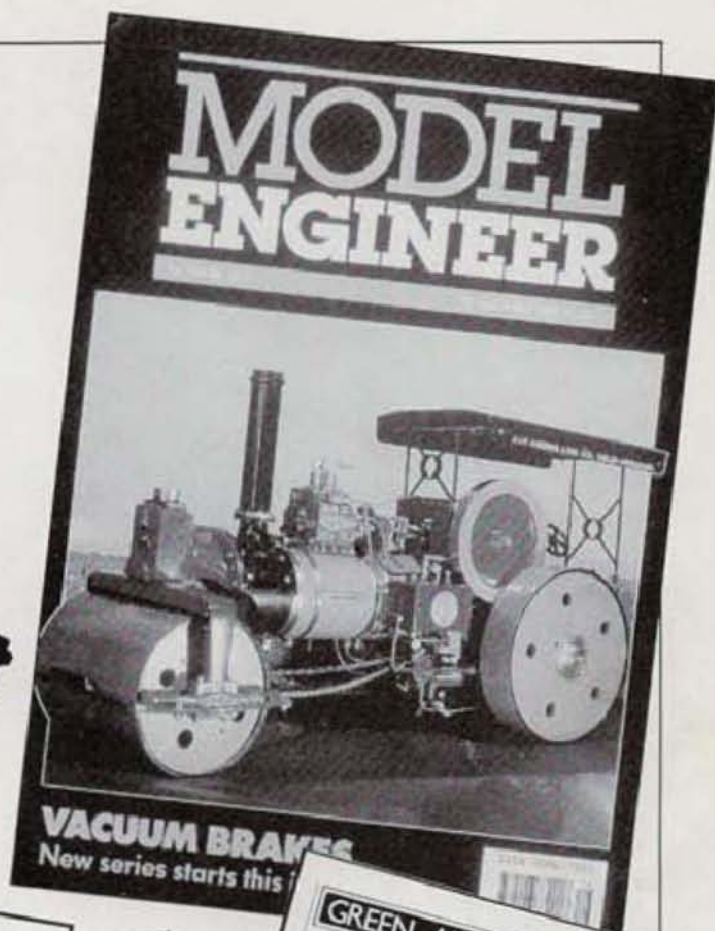
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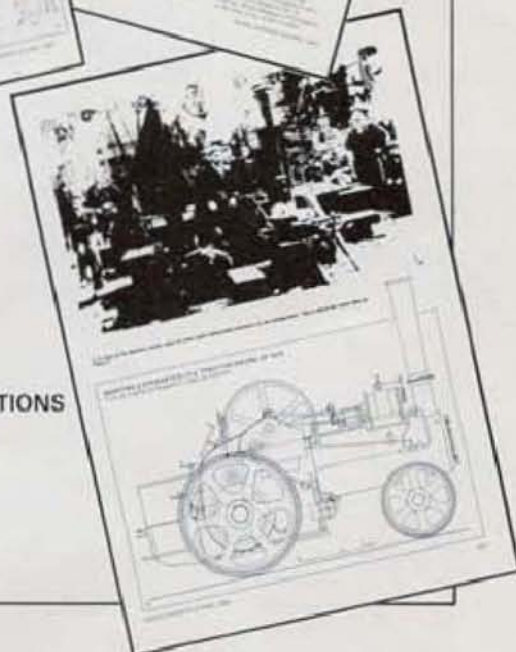
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Harold Hall

ON THE EDITOR'S BENCH

I would like to start *On The Editor's Bench*, in this issue, by thanking all those readers who have written in with encouraging comments regarding my first two issues.

One such letter did go on to point out a silly but not serious mistake I made in the last issue. As a result, I anticipated more would write pointing out the error of my ways, but so far none have been received. More about that later.

The response to the Reader Survey has been very good. A sample 400 replies were entered in to the computer and analysed. On the basis of these I wrote my first comments on the survey, which are published elsewhere in this issue. As additional forms continued to arrive I analysed these manually and added further thoughts, as you will see in the report.

Forms are still being received, to date about 620 replies have arrived. If you would still like to contribute please send in your form as I will read all that are sent, even though they will not be included in the computer analysis.

Just one point I feel is worthy of being expanded on, over and above that in the survey report, relates to those of our readers who consider themselves novices. Whilst, initially, those looking for a more demanding range of articles appeared to balance those requesting for more very basic information, it became obvious that this was not so.

Later consideration of the replies showed far more readers looking for a greater number of articles to benefit those with little experience. I hope the more experienced will accept it, if they notice a little move in this direction. I will not comment further about the survey here, in this issue, but may do so from time to time in later issues.

Some readers took the opportunity to include letters with the forms, resulting in a considerable increase in the number of letters received. It is my wish to answer all correspondence though, under these circumstances, it has not been possible.

The unexpected popularity of *Model Engineers' Workshop*, from the first issue, meant that the quantities being printed had to be increased with each of the earlier issues. The quantity of requests from readers who missed Issue One, was sufficient to justify a reprint of the first issue.

As the print run for Issue Two was immediately increased the requests for back copies was less, and as a result it would not be economical to do a reprint. Even so, there are many readers looking for this issue, as I have many requests for

help in this direction. If you are a reader who does not keep your magazines beyond a year or two, could I request that if you intend to pass them on as waste paper, please let me know and I will find Issue Two a good home (postage plus paid).

A reader has rightly pointed out the danger of using Trichloroethane as a degreaser as suggested in *Quick Tip*, page 33, Issue 7. Whilst I agree that the use of this in quantity presents a hazard, I feel if used as suggested in the tip, it should be perfectly acceptable.

The bottles of correcting fluid thinners contain only 20 ml and with the spout included as part of the bottle, it can only be available a drop at a time.

With the arrival of photocopiers, this correction fluid is now used in many other areas than typing. In the firm I have recently left, it was used extensively by engineers to mark up copies of existing drawings. These were then passed on to the drawing office to produce new designs; it became known by some as engineers' white. As a result these bottles of thinners are used in large quantities and should be acceptable if used as advised. Even so do not attempt to break off the spout to get at the fluid in larger quantities.

In this issue you will find an article on a taper attachment for a Myford Series Seven lathe. I mention this for two reasons, the first most significant.

This article is the first where the design was established on paper, drawn, and the article written. We are indebted to Mr N. Smith of Low Moor, Bradford who, using the drawings and text, made this item and photographed it.

My second point related to many requests from readers for more articles on attachments for other than the Myford Series Seven. I have to say that we can only publish what we receive, and that means almost all with few to spare.

If you are conversant with computer jargon you will probably know **WYSIWYG** as, "What you see is what you get"; this is a case of **WWGIWYS**: that is, "What we get is what you see."

Now if each owner of a Boxford, or a Harrison, or a Colchester, provided me with just one item, I could change the situation to help meet those wishes, so how about it?

Now to my admission: during my three year spell in Jig and Tool design, during my apprenticeship, all my drawing was done using one type of drawing projection. Having left that some 35 years ago I soon went to a firm, though not in the drawing office, who used the other common form of projection. After that time span, probably

without ever referring by name to the projection used, the name for the projection was well and truly lost amongst all the new data required in a rapidly changing electrical industry.

When producing the drawings for the Toolmaker's Hammer I decided to add the projection name to these and went in search of a drawing with the information on. The drawing I found was either wrong or I misread it.

But still I now have an easy way to remember being. The first method of drawing I used was first angle, and the second method of drawing I used was third angle. Where did second angle go to? Can any reader explain how these terms were arrived at?

The digital readout article started in the last issue, detailed very precisely where the various components could be purchased. I had intended to give some additional information for our overseas readers. Almost all components are universally available and should present no difficulty in locating alternative sources of supply. Two components where this is not the case though are the two PCBs. The power supply could, however, easily be achieved by some other means, but this still leaves the counter PCB.

Electromail say they will not deal with export orders (but you could try), but their industrial section (same catalogue and catalogue numbers) known as R S Components Ltd do, but may not be willing to supply to private individuals. The address is R S Components Ltd, PO Box 99, Corby, Northants NN17 9RS, tel. 0536 201234.

R S Components do have the following overseas outlets:-

Germany R S Components GMBH 6105 4501234
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Australia R S Components PTY 9244 3666
New Zealand R S Components Ltd 9881 612
South Africa Elvey Int. 11614 6541

Any overseas reader having difficulty obtaining this PCB please write to me, and I will endeavour to help.

Last time I said I would publish a list of articles requested by readers, hoping that another reader may have specialist knowledge in the area and could, as a result, provide an article for publication. A similar list of readers' material requirements is published in *Scribe a Line*.

The following are a few requests from a much longer list. If you feel you can help, please write first with brief details. This will avoid two people spending time producing similar articles:-

- Making and using broaches
- Metal spinning
- Band saw blade welder
- MIG welding
- Machining stainless steel and bronze

Among the subjects outlined above, it may be worth remembering that several have been covered quite recently in our sister publication, *Model Engineer*. One request was for articles on patternmaking, which is currently receiving much attention, both for conventional sand casting (By Chuck, B. Terry Aspin) and for Investment, or Lost Wax Casting. This latter was a full cover photographic series which explained the entire process.

SCRIBE A LINE

Your views, your pages! Your opportunity to make your point, ask the question or simply pass on a snippet of interesting advice to others. Your letters for publication in *Model Engineers' Workshop* are always welcome

Many letters are received from readers requesting assistance in locating materials and services. It is intended to include in *Scribe a Line* a list of these requests, hoping that some other readers will be able to offer suggestions for a source of supply. If you can, please do write with your suggestion, I would welcome letters from suppliers also.

Similarly if you have a problem with the non availability of some item, do also write, and your requirement will be added to the list.

Where the content of the letter warrants it, the complete letter will be published, as in the past.

I would like to be able to research this information myself, but time does not permit. The suggestions received will be published, and not just conveyed to the original enquirer.

- 1) Left hand taps and dies.
- 2) Angle in stainless steel.
- 3) Square silver steel.
- 4) White metal for bearings.
- 5) Foundry supplies, sand, crucibles etc.
- 6) Solidox, solid oxygen pellets (sodium chlorate).
- 7) Small grinding wheels.
- 8) Silver steel in long lengths (1 metre).

ATTRACTING RECRUITS

Mr B. A. Martin of Solihull is concerned where the next generation of model engineers will come from. Our survey shows that in any case only about half come from an engineering background.

Reading MEW since the first issue, I have become concerned that no mention is ever made of how the next generation of model engineers will arise.

The demise of Midlands engineering, which started its continuing slide into oblivion as long ago as 1968 has resulted in curtailed training schemes and the virtual abandonment of apprenticeships, and thus prevented the replacement of retired or redundant turners and millers. This has now reached such a degree that the nation as a whole must possess more rusting machinery than it does skilled operators.

Evening classes in light engineering skills are almost non-existent; day schools or day release virtually unobtainable

beyond ones early twenties.

My own skills are minimal, even though I have owned my £25 worth of 9 in. x 20 in. South Bend with the 8 x 5 geared lead screw for twenty years.

There was never the time to acquire the skills from a real expert, nor even to ask. Who can now teach a new generation, except the dedicated model engineering buffs?

B.A. Martin, Solihull

BATCH WORK

Following up the article on drilling jigs in the Oct./Nov. issue Mr H. Pierce of Tenerife, Canary Islands, makes his own suggestions on the use of templates. He also like Mr Martin (*Scribe a Line*, this issue) sees the benefit of this and similar magazines, to the up and coming metal working craftsman.

I have taken the M.E. since the 1920s, and think I should have never got through my apprenticeship as an instrument maker, without the expertise of its contributions. Alas, now one needs to purchase about 4 magazines, to get the same broad coverage.

The copy of Workshop that I have is the Oct./Nov. issue, brought out by a friend and I recall the production and photographs far superior to the old Percival Marshall M.E.

But Sir, the articles have all been published many times before in M.E. I recall making a collet adaptor and collets for my Drummond flat bed, sometime in 1939, but I suppose a new generation will not have seen them.

Reading the article on drilling jigs, I recalled how we used a different procedure for batch work. We used $\frac{3}{16}$ in. thick zinc sheet as templates, these were marked off using odd legs and dividers, and $\frac{1}{16}$ in. holes were drilled as required.

These templates were clamped to the work, and a $\frac{1}{16}$ in. dia. centre punch used to spot through the holes. These centre dots were picked up with a $\frac{1}{16}$ in. drill after the template was removed, and then were opened up as required.

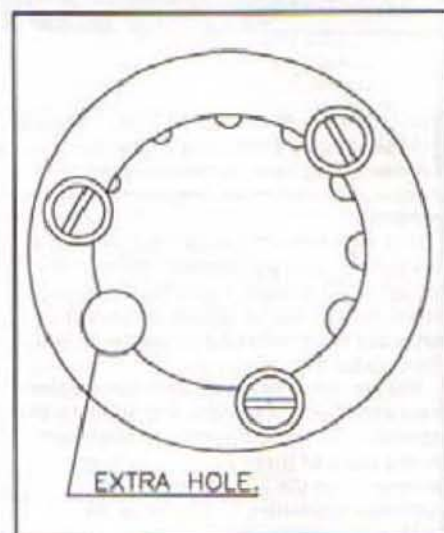
The advantage was the ease of marking out, and the use of the centre punch obviated any wear on the holes in the template. The punch was turned from $\frac{3}{16}$ in. dia. silver steel, and the point about 45 degrees. These templates and the punch too, lasted many years.

I enjoyed your magazine, and since Sir you are one of us - a "craftsman" - (I do hope I can live up to this - Ed), I wish you and it every success.

H. Pierce, Tenerife

JACOT TOOL - MORE VERSATILITY

Mr W.S. Kirshner offers this idea to enable extra holes to be added to the Jacot Tool as described in the Aug./Sept. issue.



Prompted by Don Unwin's article on pages 64, 65 of the August/September 1991 issue of MEW, I made my version of the Jacot tool, using two chunks of 2 in. by 1 in. rectangular section aluminium alloy and 6 s.w.g. brass discs finishing at just under 1 in. outer diameter. Articles concerning the Jacot tool that I have read all assert that further holes cannot be drilled once the disc is "finished", as stated in lines 11 - 12 on page 65 of Don Unwin's article. This need not be the case. For each disc, I machined an annulus of similar material, so as to surround the disc with only slight clearance, but 0.003 in. thinner; I drilled through it for three equidistant 6 BA screws and nuts, each with a washer on each side, so that the Jacot disc was "pinched". Thus further holes may now be drilled at any future time. These measurements may need modification for larger discs and holes. There is, moreover, a bonus - the annulus will protect the holes!

W.S. Kirshner

HISTORY OF MACHINE TOOLS

One of the results of our reader survey, was an unexpected interest in the history of machine tools. Do we have any readers who are members of Industrial Archaeology Societies, or who have special knowledge in the subject? In this letter we have a request for details of museums which display old machine tools.

During a recent visit to the Science Museum in London, I decided to take a look at the old machine tools on display. I was surprised and disappointed to find there was only one machine of note, being a rather special short bed lathe, probably a wheel turning lathe.

This led me to consider whether there are any museums with a better display. There are many museums devoted to a

single subject, is there anywhere a museum specifically for machine tools, or maybe, a manufacturer with a private collection.

If any of your readers have knowledge of such collections, I would be pleased to learn of their content and location.

A COMPUTER PROGRAM

Mr Pooler of the Kyle of Lochalsh has come up with an interesting computer program. Any reader interested in a copy, please send a stamped self addressed envelope marked "Screwcutting Prog" and a copy will be sent.

The article Number Crunching for the home workshop by Dr Phillips was very interesting as I had done a similar exercise some years ago. I had a mixture of purchased and home made gears for a home made lathe. These enabled all standard size Imperial threads to be cut. With the help of a home computer I found that the same gears could be used to cut all standard size Metric and BA threads to an acceptable accuracy.

My program is less sophisticated than Dr Phillips' program and takes ages to run but has the advantage that the output tells me exactly which of my gears to use.

Other readers of MEW may be interested and a copy of the rather lengthy program is

enclosed. The program is written for my range of gears but can easily be amended for any other range. In my case the gear on the lathe mandrel has 64 teeth, I have 10 other gears and the pitch of my leadscrew is 16 TPI. These values are assigned in line 20 to the variables DRIVER, GEARS and LEADSCREW respectively. The number of teeth on each of the 10 gears are assigned in line 40 to the variables P(1) etc. Anyone else wishing to use the program should use their own values in lines 20 and 40.

A copy of the screen following a run is

WIGGLERS

Don Unwin throws some light on the early days of the Wiggler/centre locator.

In your editorial paragraph of the current issue (No. 7) you refer to edge finders and when they may have been first used, I have a number of very interesting and useful tool catalogues dating back to 1910. However, the earliest I can find with reference to an edge finder is that of Alfred Herbert, Catalogue No. 15, undated by acquired by me in Feb. 1958. I enclose a copy of the relevant page. I seem to recall the 'Offen' brand of tools during the latter war years.

Don Unwin, Hitchin

included at the end of the program. I should add that the program does not consider if it is possible to set up the gears without clashing and some of the output may have to be rejected.

I find MEW full of information and interesting ideas and look forward to its arrival every two months.

W.J. Pooler, Kyle of Lochalsh

CAD/CAM - HELP SOUGHT

I thought it would be good to publish this letter, from the Pengwern Further Education College, Rhuddlan, Nr. Rhyl, run by the Royal Society for Mentally Handicapped Children and Adults. This is just one indication of the wide ranging readership that MEW caters for. A review of the Unimat CAD/CAM PC will shortly be published.

We find your magazine very enjoyable and useful. As part of our training facilities we have a Vocational Training Unit which has several different kinds of workshops for our students including an Engineering one with a Myford Super 7.

We also use computers, including an IBM compatible and a BBC master. We are considering running a lathe off one of the computers and would welcome any information or accounts of readers experiences with the UNIMAT PC, which

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OFFEN CENTRE LOCATOR—cont.



Fig. 2

amounts until the stem runs off along the surface (Fig. 2). As the distance of the end of the stem is .001" the datum face is now .001" from the machine spindle centre line, and by reference to the micrometer dial on the machine table controls, the required relationship between the spindle centre and datum face can be obtained.

When working from vertical datum faces, the direction of the spindle rotation should be such that the stem will run off downwards.

LIGHT LINE METHOD

As the stem will not run off the surface of the work until it is forced beyond the centre line of the spindle, run-off accuracy greater than .0005" cannot be guaranteed. When greater accuracy is required, the light line method is used.

The stem is allowed to centralise itself as before, but the table is raised until the flickering light between the end of the stem and the datum face disappears, so that the stem appears to be running on the surface of the work. Accuracy to within .0002" can be obtained by this method.

To avoid having to rely on the accuracy of the machine screw for positioning slip gauges are built up to the required height less .0001", and the centre relation obtained directly by either the run-off or light line method.

An extension is supplied with the Centre Locator, which enables setting to be done at a greater distance from the machine spindle (Fig. 3).

Two stems with parallel and radiused ends are supplied for working from round and flat datum faces respectively.

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RUN-OFF METHOD

This method is dependent on the action of a spring-loaded stem, which, when forced past the centre line of the machine spindle by the pressure of the datum face, runs off along the surface.



Fig. 3

With the work set up ready for positioning, and the Centre Locator held lightly in a drill chuck, the stem is pressed off-centre and the machine run at between 200 and 500 r.p.m. The machine table is raised slowly and the stem gradually centralises itself by tapping lightly against the datum face. When the stem appears to run about true, the table is raised by noted

we are considering buying. We would also be interested in any information from people who run a Myford with a computer.

Correct me if I'm wrong but I can only find one article in MEW on computers and that did not mention CAD/CAM techniques.

Thank you for any help and advice you or your readers can offer.

Howard Gilmartin, Head of V.T.U.

RAGLAN LATHES

Can anyone help Mr Andy Taylor of Kidderminster regarding his Raglan 5 lathe

I would like, if at all possible, to use the pages of Scribe a Line to establish two things. The first is whether any of your readers happen to know of a source for spare parts on a Raglan 5 in. lathe. In particular I am interested in a gearbox that can be fitted to the above lathe.

Should I be unsuccessful in my search I would like to know if there are any readers who have drawings that could be utilised to make a gearbox that will fit to the Raglan. I have studied with interest the recent articles re. a gearbox for the Myford Series 7 lathes but unfortunately my knowledge of engineering is rather limited and I have been unable to ascertain whether it is possible to adapt the design of the gearbox for the Myford to actually fit the Raglan. I would be very grateful for any information that I can get on the subject.

Incidentally the purpose I actually use the lathe for is to modify and build Pneumatic Air Rifles. It is interesting to note that the British manufacturers are actually at the forefront of this technological innovation whilst the accepted front runners, namely the Germans, have been caught napping and most of this is due to the input from what could be loosely termed "model engineers". I believe that lessons can be learned from this and "back garden inventors" should be cultivated by large companies as most of them have got a determination to succeed that is in my opinion equally important, and often better, to that of a large budget.

Andy Taylor, Kidderminster

SINE BAR CLINOMETERS

Mr R.F. Thomson of Paignton refers, in this letter, to a sine bar clinometer as a "scarce piece of equipment". (Definitely an item of which I had heard, but had almost no knowledge. Ed.) Yet we have two references to it, in this issue, see also the article on Lathe Alignment.

I was most interested in the dividing device described by Mr Longworth, in the August/September issue of MEW, particularly as I myself use a rather unorthodox system for dividing on an ML7 lathe. Unfortunately, my arrangement relies upon the use of a relatively scarce piece of equipment, which has not been generally available since the immediate post war years.

Mr Longworth does stress that his equipment becomes increasingly subject to cumulative error, with the increase in the number of divisions used. Of course, this is due to the adoption of just one length standard, any error in which is repeated, and added to, at each step of the division process. In this respect, his method does

appear to be at a disadvantage when compared to the simple changewheel system, since whilst changewheels may not be renowned for extreme positional accuracy of their teeth, they are most certainly not subject to any cumulative effect. For instance, if one were to cut a 60 tooth 20 DP wheel using his equipment, an error of only 0.001 in. in the length standard, could produce a linear displacement error in the position of the final tooth cut, amounting to 0.045 inch. This calculation is based upon the 4 in. PCD which he adopts for dividing, and the 3 in. PCD of the cut wheel.

I do not overlook that the author recommends that the accuracy be checked over the full revolution, before machining commences, although this does seem to involve quite a lot of extra painstaking work, not normally expected with this kind of operation. On the other hand of course, his method does confer the advantage that any number of divisions, including non-integer divisions, become possible, which cannot be done using just one simple changewheel.

The method of division which I have used for many years in my own workshop also confers this advantage, with little or no cumulative error. However, as stated earlier, the necessary equipment would now be difficult to lay hands on. It relies upon a clinometer made during the war years, as part of an artillery sight, to determine angle of elevation. It takes the form of a 45 degree brass quadrant, detented at one degree intervals, over which may be moved a radial bar, pivoted at the centre of the arc, which bears a moveable and very sensitive spirit level vial. Now, the 'trick' is, that this radial bar is not straight, rather it is slightly curved, at a constant rate, so that as the vial is slid along the bar, its slope gradually increases, as it progresses away from the pivot.

The vial mount carries a fiducial, that engages a scale engraved on the bar, and calibrated in minutes, which interpolate the detented degree positions. Moreover, the glass vial itself, is subdivided into 30 sec. intervals, and such is their spacing, that intervals of circa 15 sec. may be easily judged.

In use, this clinometer is mounted on a transverse, 1 in. square bar, pivoted at its centre on an expansive extension of the lathe mandrel, at the rear end, much in the same manner as the device described by Mr Longworth. I also use a mandrel clamp of the split type, which bears on the outside circumference of the register immediately behind the chuck. This clamp is in turn anchored to a stanchion, screwed into the tapped hole, provided by Myfords, in the lathe countershaft casting, to accommodate their 'Quick Change' collet attachment.

With the mandrel initially clamped, and the clinometer on its transverse bar, adjusted to zero, the first machining operation is undertaken. This is followed by adjustment of the clinometer setting to an angle, equal to 360 deg. divided by the required number of divisions. The mandrel clamp is then released, and the mandrel turned until the vial bubble again centralises. The mandrel is then re-clamped, and the second machining operation is performed. This process is repeated for each subsequent operation

until the step immediately preceding the 45 deg. limit is reached. At this stage, with the mandrel still clamped, the transverse bar carrying the clinometer, is released on its expansive insert, in the rear of the mandrel bore, and returned to its starting position and zeroed. This is followed of course, by re-tightening the transverse bar pivot in the mandrel bore. Again, the whole sequence of events is repeated, until the clinometer setting, once more reaches the step preceding the 45 deg. limit. In this way one may progress around the full 360 deg., in stages.

Before starting work, it is best to divide 360 deg., by the number of divisions, to arrive at the angular subtense between individual divisions, and it is important to do this using a calculator which displays a fairly large number of significant digits. This figure, expressed in degrees, and decimal degrees, is placed into a calculator store, and recalled for each subsequent operation, before applying the appropriate multiplier. In this way, cumulative error is reduced to vanishingly small proportions, bearing in mind that say 9 or 10 significant digits will be in use. Finally, after each clinometer setting is calculated in degrees, and decimal degrees, this is converted to degree - minute - second, format, for application to the clinometer itself. My Hewlett Packard calculator has a pre-programmed, single key function, for this conversion.

In a letter such as this describing a rare type of equipment, it would not be appropriate for me to go into much greater detail. However, if sufficient interest were to be generated, I would be very happy to expand upon the matter.

It will be appreciated that, whilst there will be inevitable errors of adjustment/calculation (rounding etc.) at each step, these will be randomised, and should not result in cumulative error.

As a matter of interest, the clinometer in question was manufactured by Watts of London, and was advertised (Ex Govt.) by United Technical Supplies Ltd., in Model Engineer, dated 11.9.58 - Page 350. It is also featured in W.A.J. Chapman's book 'Workshop Technology - Part 3', on page 224, where it is also illustrated.

In conclusion, I must express my gratitude for the published reply (MEW Aug./Sept. 1991 - 'Scribe a Line') to my earlier letter concerning the subject of polygonal cross sections from circular bar, which confirmed my surmise.

In Model Engineer advert dated 11.9.58, this clinometer is described as a 'Sine Bar Clinometer', which may reflect its original purpose, since it would be well adapted to use in conjunction with a sine bar. However, I do know that when they were sold 'Ex Govt.' they were usually described as 'Goni Sights'. It seems possible that they were in fact extemporised for this latter purpose, although other readers might have better information.

It will be seen that at this time they were priced at 35s. 0d, although I seem to recollect that I purchased mine from Buck & Ryans, when they were located in Euston Road, London, and the cost, from their surplus tray was only 25s. 0d. In fact, I also recall that the purchase was made on the recommendation of the then manager, with whom I was on nodding terms. Needless to



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say, I have never regretted the investment.

I believe that a fairly substantial number of these clinometers were available on the market back in the '50s, and it would be quite interesting to learn whether any significant quantities may have gravitated into the hands of our fraternity. Another type available at the time, was of the 'end pivoted' kind, with a (minute) calibrated lift screw at the other end. I also have one of these, and the level vial is about twice as sensitive as that on the device described above. However, it has a span of only 10 deg, which makes it far less practicable for division purposes. I use it mainly to detect twist in machine tool beds, to which purpose it is very admirably suited.

Doubtless, you will be correcting the error in the first chordal value appearing in Mr Longworth's table on page 67, which should read 4.000 inches, not 6.283 inches. However, because of the very large rate of change of angle with chordal value, for only two divisions, it seems most unlikely that this method would be used to divide into only two parts, in view of the possible error.

R.F. Thomson, Paignton, Devon

CONDENSATION & ELECTRONICS

Mr G.K. Bartlett of Selly Oak has some interesting comments regarding two articles in the last issue. Most interesting, he confirms he has already used the friction flag method for count reversal, put forward as an alternative method in the Digital Readout article.

The mag. keeps up its high standard as usual and each issue is eagerly awaited.

May I add some comments on items in the last issue. Firstly the article on condensation as the dread season is upon us again. The article is a great help and does explain a lot but it is certainly the case that it is a confusing subject. The mention of surface condition is something I know to be true, (the reason I know would consume too much space) but I have never seen this stated in print before, it seems rough surfaces, even if metal, are less attractive to condensation.

My wife made me a lined quilted cover for the lathe when new and I really thought this would help, dare not tell her it made it worse. What did help though was a 25 Watt piano heater along the back of the cabinet. I have this controlled by two Temp sensors — one for air and one Bed Temp if A lags B heater comes on. This is no help for the other machines though. I get through several tins of WD40 in the bad three months.

This begs the question wouldn't our background heat be better applied to the machines themselves, i.e. a few pad heaters applied to the bulk metal might work wonders. What I can't explain though is my pillar drill stands 18 in. from the lathe and is never a problem. I can leave the chuck in bright condition with hardly a touch of oil and it never gets damp.

My space is split between shed and garage, mostly garage for machines. The car is less of a problem as I try and avoid putting it away if wet. The greater problem is making the space warm enough for me, as soon as I do this the problem starts. Placement of sources of heat is a useful factor, maybe the best answer is not to work for the worst period.

Secondly, the article on Digital Readouts is very ambitious and the writer (presumably your goodself) deserves congratulations. As an electronics man I have worked on similar lines and in fact my coordinate drill has a system almost identical, using the same readout unit as yours but using the flag system for count reverse, so I can confirm that this simplification works well. Somehow I trust it more than the proper way, I can see it working.

I eliminated errors due to the differential by making the drive (manual or power) feed the leadscrew via deliberate backlash and a friction driven flag so reversal occurs before the screw moves. This could probably be done on a commercial mill table.

Another way to make things easier for beginners would be to use the RS stock no. 341/698 EIGHT DIGIT counter module as this is quite cost effective at about £20 and would easily fit in with your design and eliminate a lot of the work.

I have one of these sitting at the back of the bench at work together with a cheapo (surplus) shaft encoder kit and have wasted too many lunch hours trying to get it to reliably reverse using the count all four edges principle, the darned thing loses counts every time at part of a REV, I suspect it is errors in the disc no amount of manipulation will make it trustworthy so it joins the finish it sometime/never pile. The idea was to make it into a direct travel measuring device but even solving the above problem still leaves the resolution one, at least 1000 lines preferably 10000 would be necessary. I was intending to try gearing it up with a pair of anti-backlash gears but no way could I compete with MITUTOYO.

As I am more of an analogue man my flights of fancy included a slidewire along the lathe bed or a long travel Linearly Variable Differential Transformer (LVDT) and quite honestly if 4.5 Digit Digital Panel Meters (DPMs) were cheaper I might have tried that way. As long as calibration points were built in it would possibly be accurate enough for the purpose and a lot easier.

G.K. Bartlett

WHITE METALLING

Can any reader help Mr Ian Johnson of Barton on Humber with information on using Babbitt Metal for lining bearings.

I do hope you can be of assistance. I require detailed information concerning the lining of bearing shells with Babbitt Metal. This has to be within the confines of a small workshop.

During my apprenticeship days I did touch on the subject, but alas have forgotten with the passing of time. Any help will be greatly appreciated.

Could I suggest that at some future date an article in MEW would be of great interest to a lot of readers, particularly those who may be rebuilding old engines, i.e. veteran cars and motorcycles and the like.

I. Johnson

(Is there a reader who could come up with an article on the subject? I know we have readers who restore motorcycles, one of you should be able to do this. A most informative article on this subject appeared in Model Engineer 2 August 1985 dealing with white metallising model bearings. Photocopies are available from Readers' Services, Argus House, Boundary Way, HP2 7ST — Ed.)

ODD MYFORD — THE SOLUTION

Mr J.A. Batchelor from Seacroft, Leeds, explains the use of the device referred to by Mr. Holben (Page 7, Dec/Jan. issue)

Re. Mr M.J. Holben Odd Myford M.E.W., issue No. 8 Dec.91/Jan.92. This item is pure Duplex and is their "Saddle Traversing Gear and Fine Feed".

The idea is to take the weight of the Fine Feed Gears off the Leadscrew, when traversing the Saddle with the Leadscrew Handwheel.

This is fully described in, in the Workshop by Duplex Vol.3, pages 63 to 74. It was in Model Engineer, but I do not know the date.

If Mr M.J. Holben wishes to contact me, I could supply him with full details.

J.A. Batchelor, Seacroft, Leeds
(Letters will be forwarded. Ed)

QUICK TIP

Space (or should I say the lack of it) is often a problem in the home workshop. To help, bench space can more effectively be used by mounting some heavy items on easy riders. These are the units sold for placing under heavy items of domestic equipment to enable them to be moved away from the wall.

By mounting such items as a small drilling machine or a surface plate on these they can be moved to the end of the bench when not in use.

The drilling machine or other items may require to be mounted on a small piece of chip board or similar with the Easy Rider below this.

The type intended for use with storage heaters are likely to be the most suitable size though these are probably more difficult to obtain. A better solution would be to make the wheel units oneself, in which case they could be exactly the size required.

FEED LEVER TAPPING AID

When hand tapping, keeping the tap square to the work surface can be a problem, particularly in thin materials.

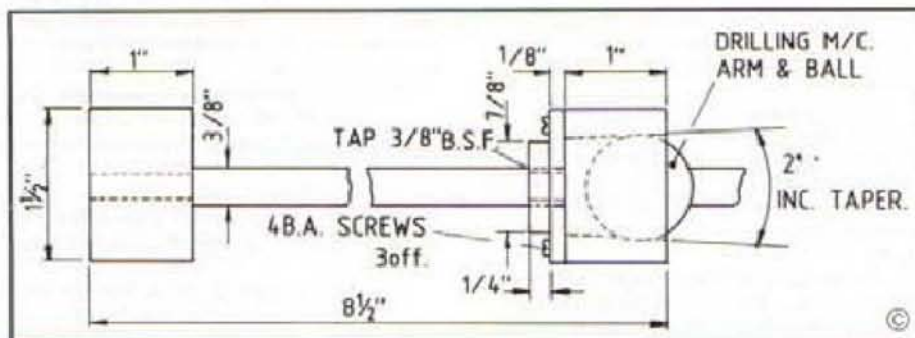
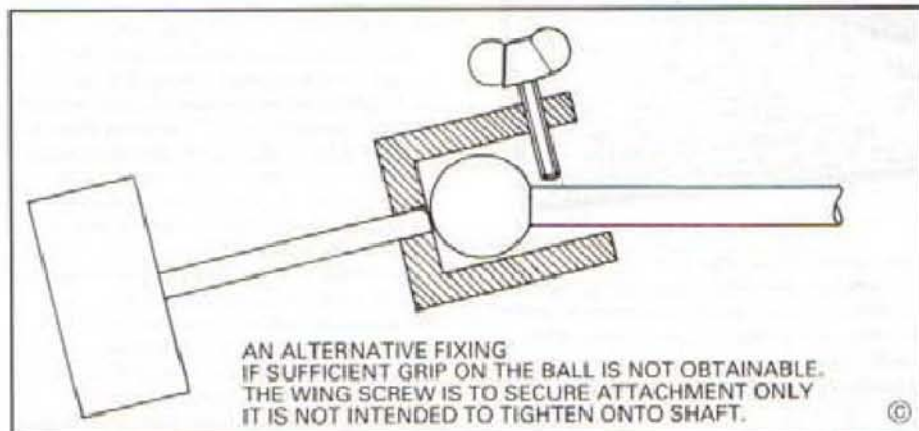
This idea by Mr J V Haynes of Cawthorne, Barnsley for neutralising and slightly overcoming the return spring on a drilling machine down feed, enables the machine to be used for tapping, thereby ensuring accurate results.

For many years I have been using a home-made drilling machine in the workshop. When starting taps in work on the drilling machine table a spring was slipped off the feed handle and taps would then be fed into the job by the free fall of the handle, spindle and chuck. I took it for granted.

Recently a new drilling machine was installed and the above operation suddenly became a problem – the spring could not be slipped off! Several make-shift ideas were tried such as tension spring and leather thong tied on weight, foot operated cord etc., but all were a frustrating nuisance. The criteria for an acceptable idea were that it must be quick, simple and effective.

Very soon after the machine was in use I became disenchanted with the plastic fittings and replaced them with 1 in. dia. steel balls on the three feed arms. What was now required was something to sit on the top feed arm ball, without even a set screw preferably. It was now I realised that an extension of around 7 in. or 8 in., with suitable weight added, would afford some leverage. A search through the scrap box turned up all the materials, i.e. 1 in. long x 1 1/2 in. diameter, Mazak bush, 7 1/2 in. length 3/4 in. rod and 1 in. long x 1 1/2 in. dia. steel cut.

The Mazak bush was bored with a slow 2 deg. inclusive taper until the 1 in. steel ball on the top arm of the drilling machine feed lever entered about three quarters of



its length. It was gratifying to note that a decent friction grip on the ball was obtained when the bush was pushed on decisively.

As the drawing shows, the feed lever was completed by an end plate tapped $\frac{3}{8}$ in. B.S.F. for the rod. The other end of the rod was reduced to $\frac{1}{4}$ in. dia. and a drive fit into the steel offset which turned out to be 8 oz. in weight. Made to these dimensions, the feed lever overcomes the spring on my machine and gives a nice, gentle down-feed. It is removed quite easily with a clockwise twist.

TRADE COUNTER



A brief look at new products for the home machinist; this time a catalogue dealing with the specialist tools used by car restorers and a CNC punched dividing plate

**FROST AUTO RESTORATION
CATALOGUE**

The latest copy of the Frost Auto Restoration Techniques Ltd 1991-2 catalogue has been received. This would seem a must for all readers interested in car restoration, as there are many items included, which would not be found in the more usual tool and machinery catalogues.

The catalogue also includes both videos and books on workshop techniques, one book *Custom Metal Polishing* covering such materials as brass, steel, aluminium, cast iron and stainless steel, may answer the question posed by Mr D. Eaves in his letter. *Scribes a Line* last issue.

Correspondence indicates that many readers are involved in car and motor bike restoration, rather than modelling as our title may suggest. For those whose interest is not in auto restoration, many of the items could be applicable to other activities, and obtaining a catalogue is well worthwhile.

The catalogue has a cover price of £1.00, but can be had free of charge providing you mention *Model Engineers' Workshop*, and enclose a first class stamp for return postage.

Write to – Frost Auto Restoration
Techniques Ltd., Crawford Street,
Rochdale, OL16 5NU.

Model Engineers' Workshop

DIVIDING PLATE

A dividing plate has been received for review from S. Vagg of Hastings. The plate has obviously been made using the latest computer aided manufacturing methods. As a result it benefits from relatively low production costs, this being reflected in its very low price compared to those made by more traditional methods.

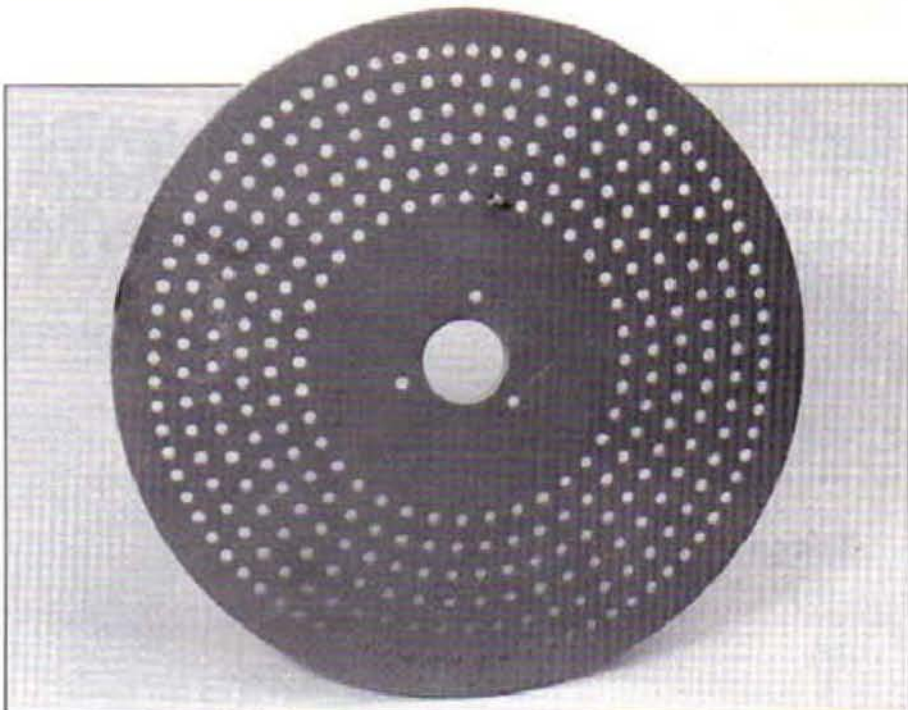
The plate is made from 3 mm thick steel and is punched with six rows of holes as follows, 36, 40, 42, 48, 60 and 100. This enables the following divisions to be obtained, using a single plunger.

Two, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 24, 25, 30, 36, 40, 42, 48, 50, 60 and 100. By the use of a double plunger all these can be doubled, thus giving the following additional divisions - 28, 32, 72, 80, 84, 9, 120 and 200.

The holes being punched are of a very consistent diameter and appearance. They are obviously intended to be 3mm diameter but measure 2.985mm.

For those readers unaware of the fact, punched holes are always made with the die larger than the punch, the difference being greater the thicker the material being punched.

This gives the characteristic taper on the rear of the hole, but will not cause any problem as the outer 3/4 rds is very accurate, both in terms of being parallel, and all being very consistent in diameter. Even with so many punched holes the plate remains substantially flat, being dished to the extent of about 5 thou.



A central hole 20mm diameter is provided with three x 3mm holes around this equally spaced on a 32mm PCD. The plate has been removed from the larger sheet by punching multiple overlapping holes to create the finished round shape, being 170mm. To keep cost to a minimum the plate has been left in this condition, any purchaser who wished could mount the plate in the lathe and turn the outer edge,

for the sake of appearance.

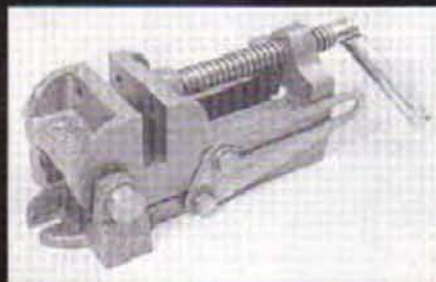
This method of production is able to place holes to a high degree of accuracy so so there should be no worry in that respect and at £10.95 plus P & P it is very reasonably priced.

For further details and possibly plates with other divisions, contact - S. Vagg, 18 King Edward Avenue, Hastings, East Sussex, TN34 2NQ, tel. 0424 713030.

IN OUR NEXT ISSUE!

Coming up in the April/May issue will be:

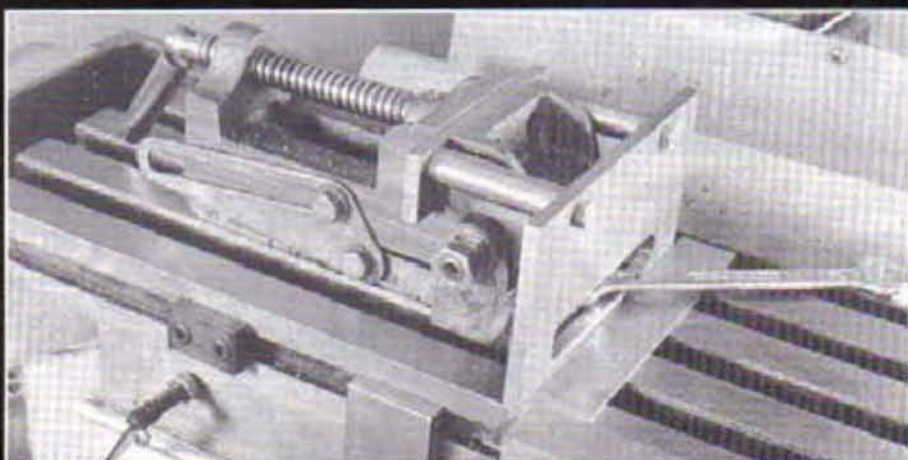
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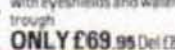
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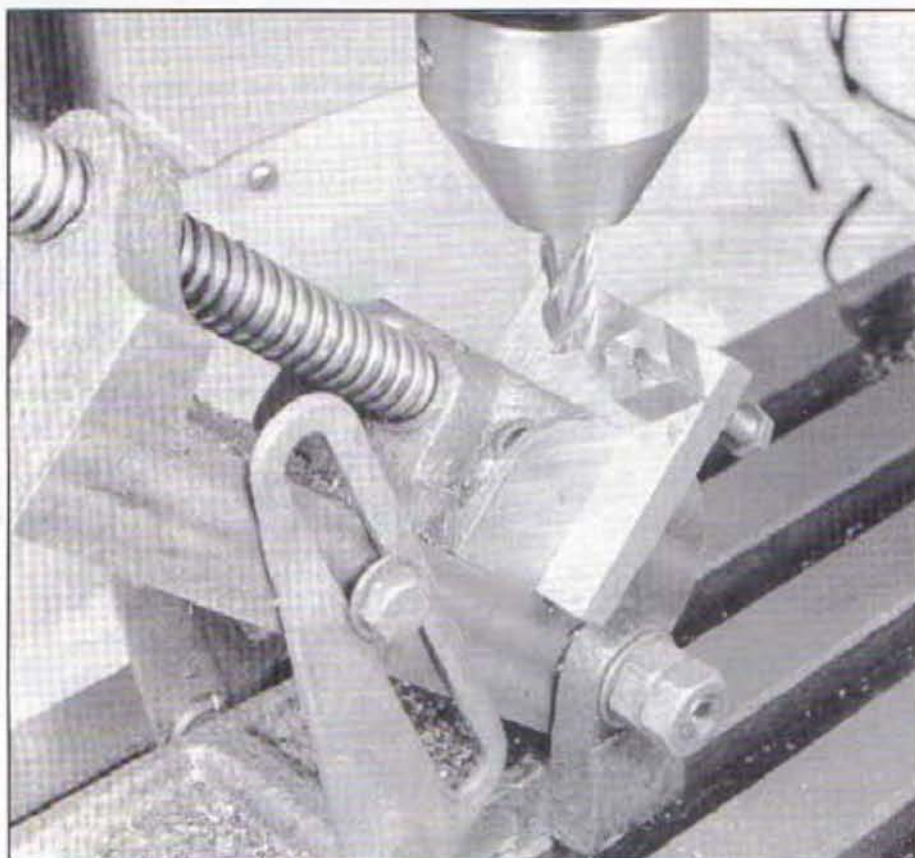


Fig. 8: Milling the groove in the body using a plate in the angle vice as part of the set-up. The body was tapped ØBA about 3 threads deep and this gave sufficient hold. Other parts can be done in similar fashion.

When we need to sharpen a drill 1.6 mm ($\frac{1}{16}$ in.) diameter or smaller, they become less easy to deal with than larger sizes. Sharpening on the grindstone or an oilstone, whilst holding the drill in a pin chuck, can sometimes produce passable results but requires practice and good eyesight.

Many years ago, in the far off days when I used to make small injectors, an old instrument maker friend showed me a gadget he used to sharpen drills down to 0.3 mm dia. I immediately made one and have used it successfully ever since. It consists of two parts held together by a knurled nut on a stud, shown separately in **Fig. 1A and 1B** and assembled in **Fig. 2**.

To sharpen a drill, it is clamped between the two parts with the tip just protruding above the apex of the square, with the flutes in the position shown in **Fig. 3**. A sharp flat oilstone is rubbed across the two flat surfaces producing two neat cutting edges. A little practice is required to get the best angular position of the drill to get the best results. Admittedly they are not curved conical surfaces, as produced by large drill sharpening fixtures, but are quite satisfactory on small sizes. The amount of relief is determined by the angle of the web with the apex of the jig. **Figs. 4 and 5** are drawings with suggested sizes (in mm) of the components. A piece of $\frac{1}{2}$ in. square mild steel bar, long enough to make both clamp and body plus a bit to allow for cutting, with nice surfaces on two adjacent faces form the basis of the jig. Drill a 2 BA tapping hole right through, then open up one end the length of the body with a

A SMALL DRILL SHARPENING JIG

If you have ever struggled to sharpen a very small drill, and I think most of us have, then making this simple sharpening jig, as proposed by Mr D J Unwin, should avoid the problem in the future

4.7 mm (2 BA clearing) drill.

Tap the remainder or clamp portion 2 BA using the clearing hole as a guide to ensure squareness and concentricity. Drill the locating pin hole from the jig clamp end, deep enough to enter the body about 6 mm, then saw into the two parts. Face off

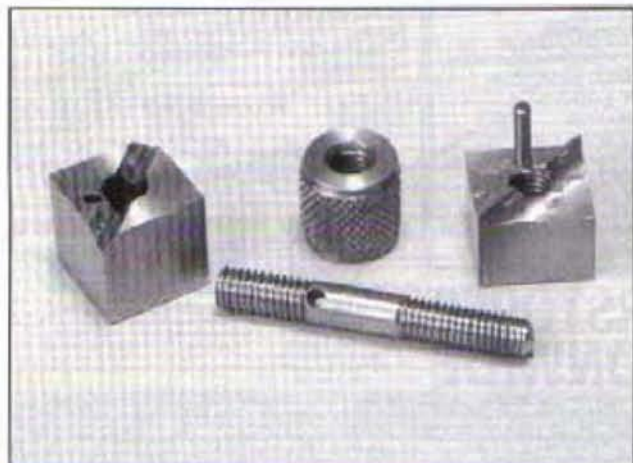


Fig. 1 a and b: The component parts of the sharpening jig.



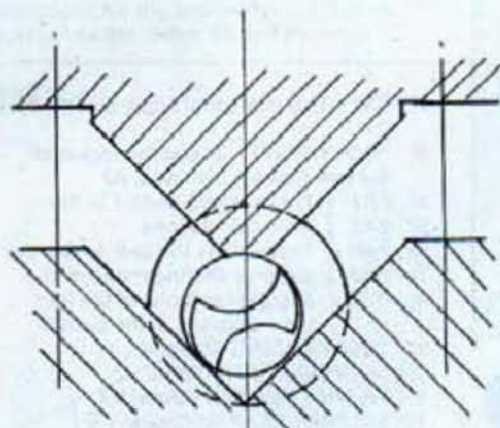
Fig. 2: the jig assembled with a drill in position.

the ends square and open out the pin hole in the body 0.05 mm larger. Mill the female vee in the body, taking great care to ensure that the bottom of the vee bisects the corners of the square and is 90 deg. to the axis. The vee should be as sharp bottomed as possible.

The male vee on the clamp then needs to be machined so that it fits nicely on the body with a gap of about 0.3 mm between the faces when the two parts are held together, Fig. 6. Fit the locating pin, either a press fit or a touch of Loctite in the clamp

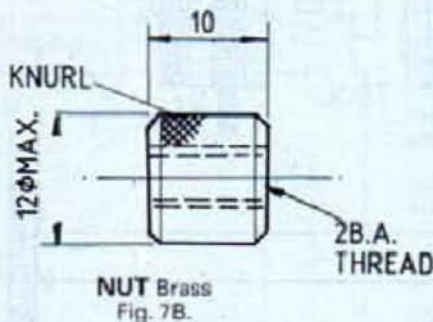
part, make the 2 BA stud with nice true threads and the cross hole then fit and secure it in the correct position in the clamp, Loctite again. Any convenient form of knurled nut can be used provided that it is smaller in diameter than the square body. Fig. 7.

My jig will hold drills up to 2 mm dia. although I don't use it for anything larger than 1.5 mm dia. It will hold drills down to 0.3 mm (No. 80) although considerable care is needed to sharpen this small size.



POSITION OF DRILL IN JIG FOR SHARPENING

Fig. 3.



NUT Brass
Fig. 7B.

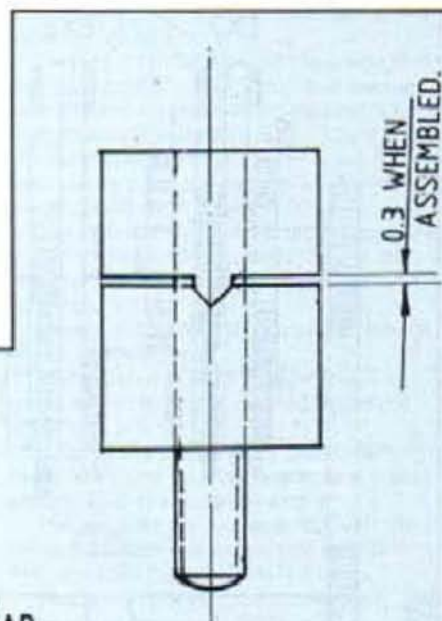
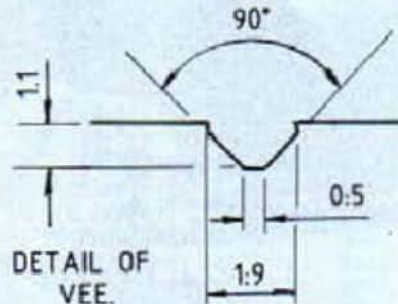
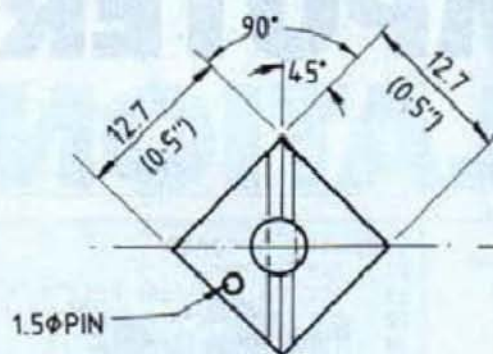
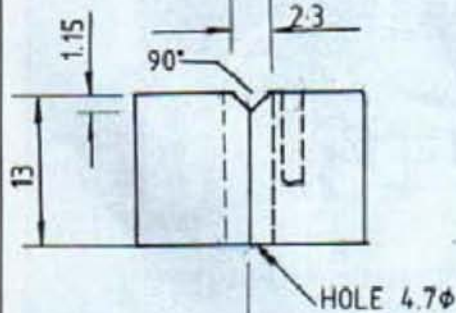
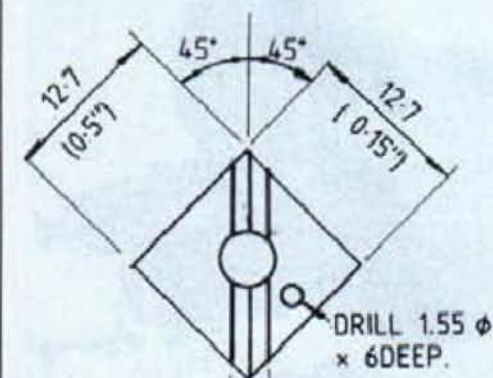


Fig. 6.

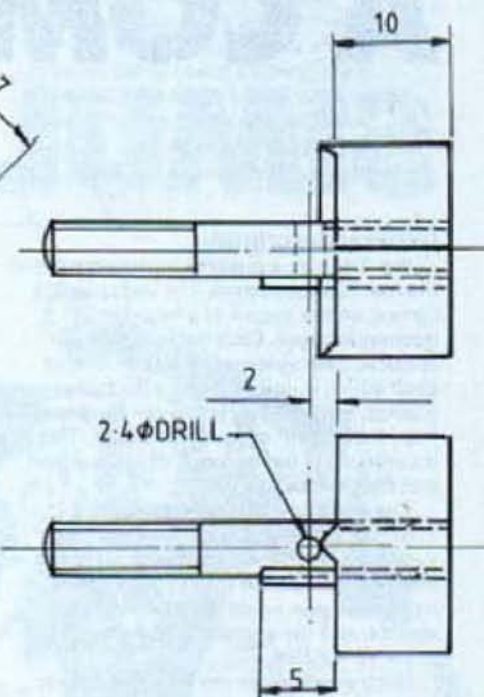


CLAMP (WITH STUD FITTED)

Mild Steel
Fig. 5.



BODY
Mild Steel
Fig. 4.



STUD
Steel
Fig. 7A.

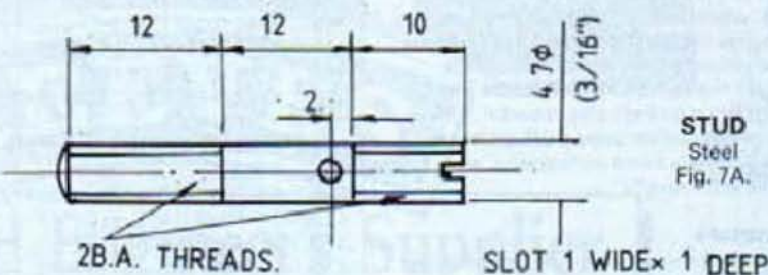
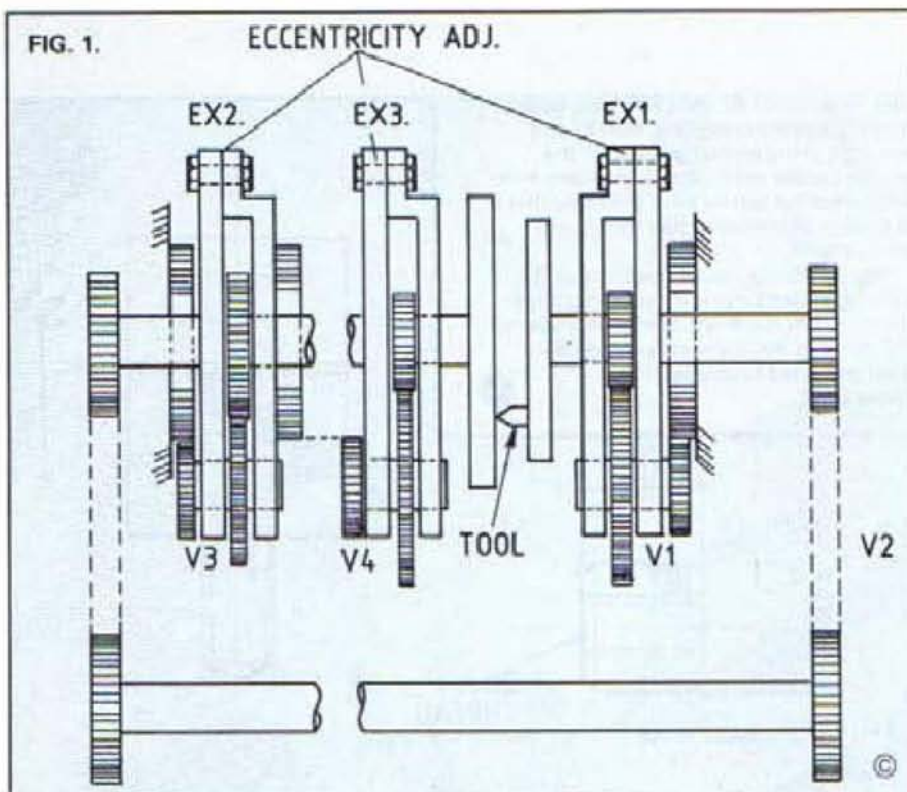


FIG. 1.

ECCENTRICITY ADJ.



In the article "Grandpa enters the Computer Age" by Mr Smith (Aug/Sept 91), he refers to patterns which he has not been able to simulate.

Mr R W Lenge of Coventry has come up with a solution published here. This is written in Dragon Basic, and will require slight modification for other forms of basic

- 2) EX1 - This is the tool angle eccentricity, R1
- 3) TOOL OFFSET - This is the radius of the tool from its own axis, R2
- 4) EX2 } These are R3 and R4 in the
- 5) EX3 } main calculations
- 6) PHI1 } These allow the user to test the
- 7) PHI2 } effect of altering the relative
- 8) PHI3 } angular positions of the four main portions of the system
- 9) TOOL GEARING (Ratio) V1
- 10) COUPLING GEAR (Ratio) V2
- 11) 1st PART GEAR (of Chuck) V3
- 12) 2nd PART GEAR (of Chuck) V4

When entering values for R1 to R4, any units can be used, either whole numbers or decimal fractions, but it is important that they should be correct relative to each other, because they are added together in line 170 and the computer decides on a suitable scale for the print-out.

A COMPUTER SIMULATION

General description

Fig. 1 shows a pictorial representation of the mechanical system. The workpiece is carried on the output of a two-part geometric chuck. Each part contains an epicyclic gear system, driving an output shaft which is carried in an adjustable bracket, so that its position can be offset from the system's rotational centre. This eccentricity is defined as EX2 for one part, and EX3 for the other.

The first sunwheel is fixed to the machine headstock, but the second sunwheel is attached to the carrier of the first part, and hence rotates with it. The individual gear ratios are defined as V3 and V4, and the overall displacement ratio is $1 + V3 + V3.V4$.

Such an arrangement would normally be used with a stationary tool fixed, for example, in the slide rest of a lathe, but in the present example, the tool is driven by a further epicyclic gear system in which the tool gear ratio is V1 and the tool axis offset is EX1.

To complete the system, the tool drive is coupled to the two-part chuck by suitable gearing, whose ratio is defined as V2. In all expressions using gear ratios V1, V2, etc., positive values signify that the output is rotating in the same direction as the input, and negative sign indicates reversal. The computer simulation allows values to be entered with this same convention, and performs accordingly.

Parameters

When the program is run, it requests the user to enter the following parameters:-

- 1) THETA STEP - This is the input angle increment, I

Computer program

```

0 REM "GEOMENG3"
10 PCLEAR4:CLS
20 DEF FNR(X)=X*ATN(1.0)/45
30 INPUT"THETA STEP(DEG)":I
40 I=FNR(I)
50 INPUT"EX1":R1
60 INPUT"TOOL OFFSET":R2
70 INPUT"EX2":R3
80 INPUT"EX3":R4
90 INPUT"PHI1(DEG)":P1
100 INPUT"PHI2(DEG)":P2
110 INPUT"PHI3(DEG)":P3
120 P1=FNR(P1):P2=FNR(P2):P3=FNR(P3)
130 INPUT"TOOL GEARING V1":V1
140 INPUT"COUPLING GEAR V2":V2
150 INPUT"1ST PART GEAR V3":V3
160 INPUT"2ND PART GEAR V4":V4
170 S=R1+R2+R3+R4 : F=94/S : T=0
180 PMODE4, 1:SCREEN1, 1:COLOR0.5:PCLS5
190 GOSUB 300 : X1=X : Y1=Y : LINE(X,Y)-(X,Y),PSET
200 T=T+I
210 GOSUB 300 : LINE(X,Y),PSET
215 IF T<0.5 THEN 200
220 IF X>X1-0.5 AND X<X1+0.5 THEN 230 ELSE 200
230 IF Y>Y1-0.5 AND Y<Y1+0.5 THEN 240 ELSE 200
240 IF INKEY $="" THEN 240 ELSE END
300 A=R1*COS(T)+R2*COS((1+V1)*T+P1)
310 B=R1*SIN(T)+R2*SIN((1+V1)*T+P1)
320 A=-A : GOSUB 400
320 X=127+F*(R3*COS(U)+R4*COS((1+V3)*U+P2)+R5*COS((1+V3+(V3*V4))*U+P3+K))
330 Y=95F*(R3*SIN(U)+R4*SIN((1+V3)*U+P2)+R5*SIN((1+V3+(V3*V4))*U+P3+K))
350 RETURN
400 R5=SQR(A^2+B^2) : U=T*V2
410 IF R5=0 THEN 510
420 IF A=0 AND SGN(B)=1 THEN K=1.5708 : GOTO 510
430 IF A=0 AND SGN(B)=-1 THEN K=-1.5708 : GOTO 510
440 IF B=0 AND SGN(A)=1 THEN K=0 : GOTO 510
450 IF B=0 AND SGN(A)=-1 THEN K=3.1416 : GOTO 510
460 TK=B/A : C=ATN(TK)
470 IF SGN(A)=1 AND SGN(B)=1 THEN K=C : GOTO 510
480 IF SGN(A)=1 AND SGN(B)=-1 THEN K=C+3.1416 : GOTO 510
490 IF SGN(A)=-1 AND SGN(B)=1 THEN K=C : GOTO 510
500 IF SGN(A)=-1 AND SGN(B)=-1 THEN K=C-3.1416 : GOTO 510
510 RETURN

```


Combining the movements

Fig. 2 illustrates the geometrical behaviour of the tool drive. L is the position of the tool after the carrier has moved anti-clockwise through the angle θ , and the tool arm has moved clockwise through the angle $-V1.\theta$, i.e. $(1-V1).\theta$ from the horizontal.

The co-ordinates A and B of point L can be calculated from the radii R1 and R2, together with the Sines and Cosines of the appropriate angles. These calculations are carried out by lines 300 and 310 in the program. Unfortunately, we cannot just add these values into the main co-ordinate equations for the two-part chuck, but we can utilise the radius R5 and the angle K.

In the main equations, one term uses R3, another uses R4, and a third term uses the distance of the tool from the centre, which is a constant value with a fixed tool, but in our case is varying. For each value of θ , the computer calculates A and B, and from them calculates R5 and K, which are then used in the main equations in lines 330 and 340.

Notes on the computer program

The program is written in "DRAGON BASIC" and runs satisfactorily on a Dragon 32 computer. The start figures in lines 330 and 340, and the scale figure in line 170, are to suit the Dragon graphics display (256 x 192 elements). These and the graphics

instructions could easily be changed to suit other computers.

The important part of the programme is sub-routine 300 which calculates the tool co-ordinates and then the main X and Y co-ordinates for the display. Sub-routine 300 utilises sub-routine 400 to carry out the conversion of co-ordinates A and B into polar co-ordinates R5 and angle K.

The statement $A = -A$ in line 320 creates a mirror image effect to simulate the fact that the tool mechanism and the workpiece face one another.

Lines 410 to 450 define all cases where either A or B is zero.

Lines 470 to 500 define the four quadrants of the circle depending on the signs of A and B.

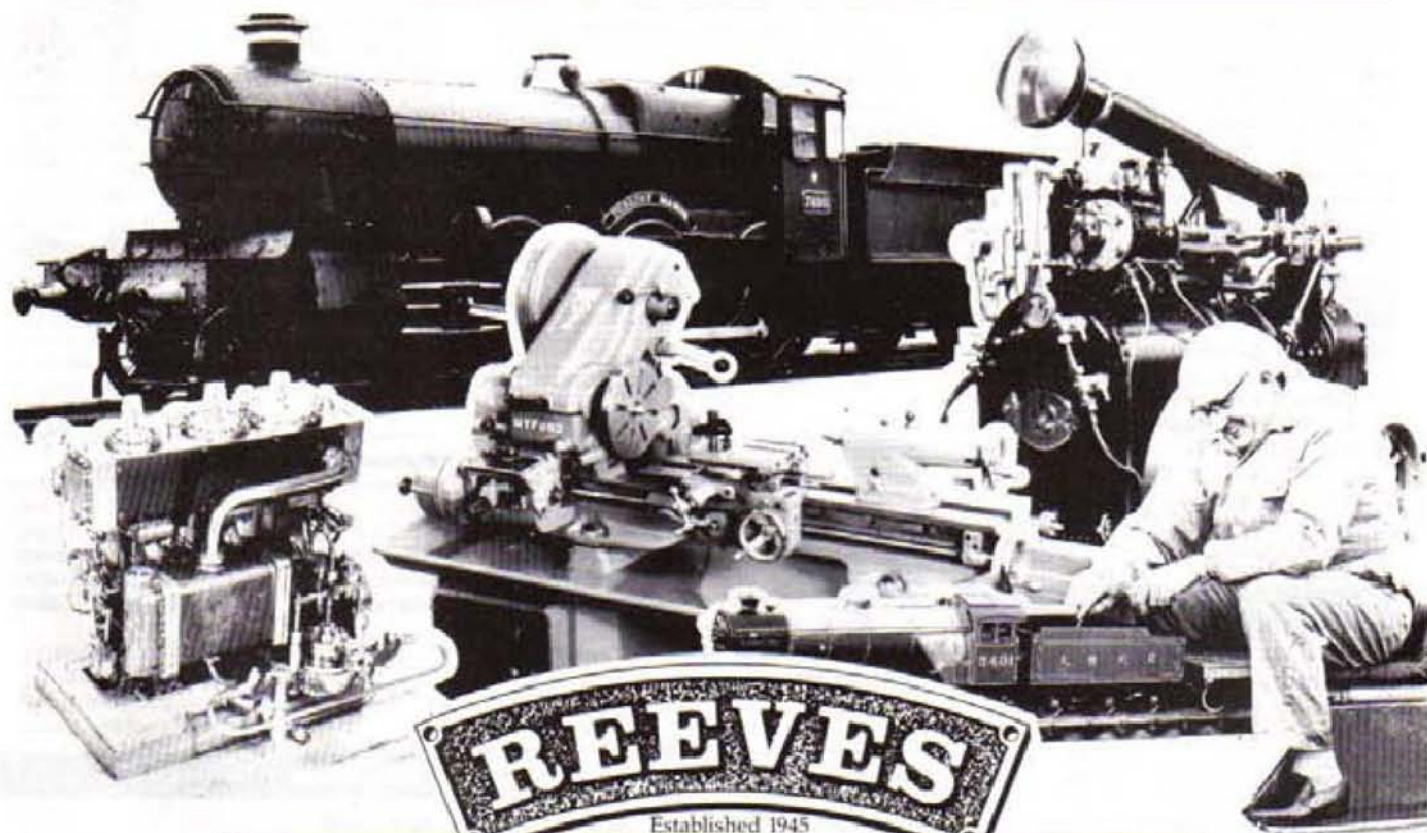
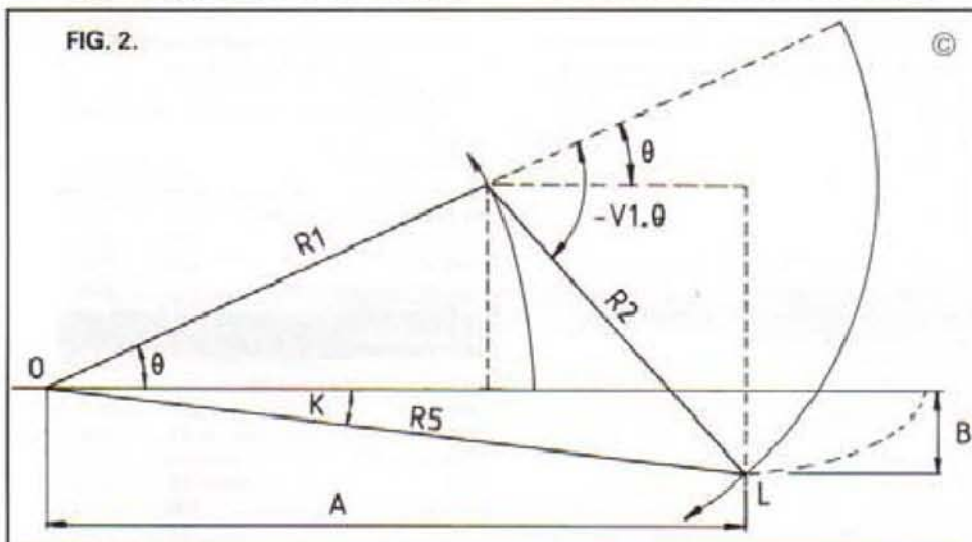
Lines 220 and 230 test if the current values of X and Y are the same as the start values. If so, the program stops.

The program can be repeated with the same parameter values by typing GOTO 170 and then press the ENTER key.

This must conclude our consideration of the geometric chuck -Ed.

QUICK TIP

Before throwing away that old umbrella frame, check to see if it is the type which uses the round wire frame, rather than the more usual small channel. If so, salvage a few of the arms as, these being a spring wire, they make excellent heavy duty spring levers. Though being of a relatively large gauge they would be difficult to use in making normal wound springs.



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READERS SURVEY REPORT

In which the Editor breaks down relevant parts of the recent Readers Survey and gives his comments on some of the matters arising.

The readers survey, contained in the October/November 91 issue of *Model Engineers' Workshop* was, of course, essentially intended, for the benefit of the publishers, not least myself the editor. Even so I find the reading of the results, very interesting from a personal point of view, quite apart from my obvious requirement, to be conversant with the views of the readers.

This interest in the results of the survey has been evident in correspondence received, and because of this the findings are being published. The figures are based on the first 400 replies, though in all 561 have been received. All readers who sent questionnaires back, please be assured, I will be reading the comments on them all.

Where an answer indicates 0%, this does not indicate that none fall into this category but that the number of replies is less than 1% i.e. 3 or less. It is inevitable that, where written comments were requested, these would cover a wide range of thoughts, and that it would be unlikely to result in large numbers making the same statements. Because of this there are many one-off statements, which would be too space-consuming to publish here, though I will comment on some of them.

There are, of course, readers with opposing views, though with one notable exception, only a few readers either way – typically, like the reader who requests more articles for the small lathe, opposed by the two who would like less.

I found it gratifying to note the level of satisfaction with the magazine, though surprised to see the high number of people who went so far as to judge it very good in most categories (question 3). I would have liked to think that readers were a little more demanding!

To make this published result easier reading, I am rearranging the relevant questions in a more logical order, and will comment as we go through the answers.

The reader

Age:		
Under 30 years	11	2%
30-39 years	39	9%
40-49 years	79	19%
50-59 years	90	22%
60-69 years	134	33%
Over 70 years	47	11%

This makes 66% in the 50 plus age group; I do not think this makes us a disappearing breed but only goes to show that the call on one's finances and time makes the hobby a more appropriate one for those of us who have survived the

demands of youth in terms of the essential expenditure of buying houses, raising families etc!

Length of time workshop ownership:

Under 10	131	32%
10-19	82	20%
20-29	60	15%
30-39	46	11%
40-49	52	13%
More	27	6%

52% less than 20 years tends to confirm my previous statement.

Annual Gross Income:

Under £6,500	50	12%
£6,501-£9,000	53	13%
£9,001-£13,000	75	18%
£13,001-£16,000	44	11%
£16,001-£19,000	45	11%
£19,001-£23,000	30	7%
£23,001-£26,000	21	5%
Over £26,000	40	10%

The spread of readers over the range is remarkably even, which shows this is not just a rich man's hobby – despite the cost of equipment.

Is or was your daily employment engineering based:

Yes	221	55%
No	170	42%

42% do not come from an engineering background which, at least in part, should allay the fears of our reader who writes in *Scribe a Line* this time.

Understand workshop electronics:

Fully	76	19%
Sufficient	143	35%
A little	120	30%
Not at all	60	15%

This shows that 54% understand electronics sufficiently to consider attempting a project – higher than I would have estimated.

Evening Class or other workshop activity attended:

Yes	66	16%
No	322	80%

Member of model engineering club or society:

Yes	85	21%
No	308	77%

Considering that a high proportion of readers will not be that close to suitable venues, these figures could be considered quite high.

The workshop

Floor Area of Workshop

Less than 50 sq. ft	82	20%
50 to 150 sq. ft	219	54%
150 to 300 sq. ft	81	20%
Larger	14	3%

Oh, to be one of the 3% with a workshop larger than 300 sq. ft!

Place of workshop area:

Indoors	74	18%
Converted garden shed	60	15%
Purpose built outbuilding	86	21%
Garage or part thereof	168	42%
Other	19	4%

Other – throws up some interesting locations in your replies such as:

Roof space
Cupboard
Desk in lounge
Sports pavilion!

Workshop conditions:

Insulated	187	46%
Heated	266	66%
Free from condensation	232	58%

Equipment

Equipment possessed:

Lathe Yes	379	94%
Lathe No	13	3%
If yes, size is:		
1-3in	82	21%
3-4 1/2in	243	64%
4 1/2-6in	89	23%
Larger	19	5%
Shaper	60	15%
Vertical Miller	183	45%
Horizontal Miller	59	14%
Offhand Grinder	317	79%
Tool and Cutter Grinder	96	24%
Surface Plate	226	56%
Drilling Machine	348	87%
Fly or Toggle Press	40	10%
Soldering/Brazing equipment	353	88%
Arc Welding equipment	179	44%
MIG or TIG equipment	46	11%
Oxy-Acetylene	63	15%
Oxy-Propane	31	7%

No real surprises here – but, on second thoughts, I was, to see as many as 14% owning a horizontal mill. . .

Following owned or used:

Micrometer	384	96%
Vernier Caliper	361	90%
Scribing Block	305	76%
Height Gauge	141	35%
Wobbler	161	40%
Depth Gauge	252	63%

Again, no real surprises; the ownership of such an item as a height gauge obviously reflects the considerable reduction in their real cost in recent years.

Workshop activities:

Also build

Locomotives	118	29%
Traction Engines	71	17%
IC Engines	66	16%
Hot Air Engines	33	8%
Model boats	73	18%
Model aircraft	53	13%

Model cars	13	3%
Clocks	72	18%
Other models	48	12%

The range of other items built was long, but did have one item that occurred frequently; 13% also made stationary steam engines. Others included (6 people) cannons, (5 people) agricultural models, (2 people) helicopters, 1 person dolls houses, etc..

Work with wood as well as metal:

Yes	303	75%
No	87	21%

This is a high figure, I wonder if some of this is just household DIY...

Prefer to make or purchase

	Make		Purchase	
Lathe Tools	246	61%	170	42%
Form Tools	148	37%	179	44%
Machine Tool Accessories	286	71%	109	27%

71% of you like to make workshop equipment. Good news for this magazine!

The magazine

Regular Column Ratings:

	Very Good	Good	Fair	Poor
Types of article	160 40%	207 51%	21 5%	1 0%
Balance between complex/simple	112 28%	230 57%	44 11%	3 0%
Quality of articles	164 41%	200 50%	25 6%	2 0%
Quality of drawings	135 33%	209 52%	45 11%	3 0%
Overall quality	203 50%	176 44%	14 3%	2 0%

The high degree of satisfaction is staggering, with very few replies as 'fair', and only between 1% and 3% saying 'poor' for any category. However, balance between the simple and complex, and drawing quality, both tend to get a lower rating than the other categories.

In the comment column, 27 readers mention poor drawings in one way or another. The reason for the lower rating of balance, I think, is less consistent, as some people request more simple articles, whilst others would like more demanding items!

Other comments include "do not use coloured backgrounds" (6 readers), "too many major construction features", "photos sometimes not clear", "step-by-step features requested" etc.

Drawing Style preference:

First angle projection	57	14%
Third angle projection	107	26%
Dimensioned work sketches	137	34%
Orthographic projections	41	10%
Drawings plus photos	300	75%

It is obvious that photographs, to back up the drawings, are a firm favourite. Otherwise there appears no real preference for style of drawings.

Preference for units:

Metric	50	12%
Imperial	147	36%
Mixture	209	52%

The low rating for metric units, I think, is probably due to most workshops, still being equipped with inch calibrated machines and measuring equipment.

Favourite type of article:

Techniques	144	36%
Machine tool aids	275	68%
New machinery	178	44%
Theory behind processes	64	16%
Other	15	3%

Interested in features on any of the following:

Other model engineer's workshops	224	56%
Visits to industrial premises	106	26%
Interviews with hobbyists	223	55%
Occasional repeats	143	35%
Workshop related articles, etc	353	88%

No real surprises, in these last two questions.

Make		Purchase	
246	61%	170	42%
148	37%	179	44%
286	71%	109	27%

General interest items not directly related should be included:

Yes	170	42%
No	208	52%

Those for and those against are almost equal on this one, the only one where we have total disagreement!

One topic you would like covered.

This list amounted to 70 items, at the top of the list was renovating old tools from 13 readers closely followed by tool sharpening, milling equipment, product tests, and history of machines.

Also with more than just one or two percent came milling work electronics, surface finishing, electric motors, etc. The requests of just 2, 3 or 4 people included lapping, an index, metal spinning. Amongst the individual requests we had basic mathematics, making a fret saw, making nameplates, etc.

Do you read

Back issues referred to:

Once a week or more	65	16%
Once a month	174	43%
Once a quarter	104	26%
Once a year	35	8%
Never	12	3%

Number of other readers:

No-one else	319	79%
One other	64	16%
Two others	13	3%
Three others	1	0%

For the statistically minded it works out to 1.23 readers per issue!

A further review

Since preparing the above from the information provided from the computer input of the first 400, I have now received the actual forms, and reviewed the comments with regard to question 3 and, as a result, can now give a more detailed explanation of this most important question.

Whilst the comments were varied, the majority could be placed in five groups, plus a miscellaneous group.

372 replies made no adverse comment and fell into the categories of good or very good.

The next major group (39 replies) commented on poor drawings, but were otherwise satisfied.

This was followed by two groups, but with opposing views; 24 replies called for a more complex level of articles, but this was just overtaken (26 replies), by those wishing for more simple articles for the beginner, or reader with only very limited workshop facilities.

Nine readers were not happy with the magazine's general presentation - too much colour backgrounds to text and drawings, etc.

A further 24 could be classed as 'miscellaneous', though there was a number in this group, who commented on some poor aspects with regard to safety. The comments with regard to drawings is not unexpected, and I would hope that some improvement will have been seen in this area in the last issue, and more so in this. With this problem largely resolved we would have 411 satisfied, and 83 still not totally happy.

With the forms to hand I also reviewed how many had come from abroad and found that 30 had originated from outside the UK as follows: New Zealand 2. USA 4. Australia 9. Switzerland 1. Canada 3. Germany 1. Sweden 1. Hong Kong 2. France 2. Denmark 1. Holland 2. West Indies 1. Canary Is 1.

A special thank you to all overseas readers who replied; they even had to pay their own postage, as Freepost was not available to them!

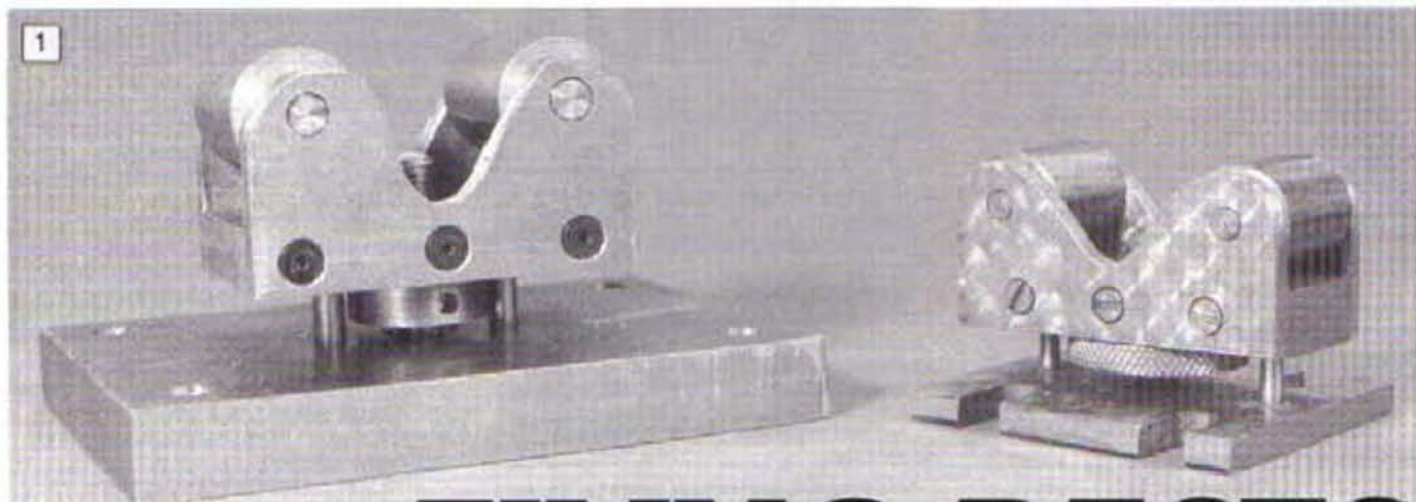
Some final thoughts

There is not a lot that can be done to satisfy fully those with opposing views, other than maybe to publish a few even more demanding projects (does the Digital Readout in this issue fit this requirement?), together with some even simpler projects for those who wish this also. This would leave a little less space for those average projects, which fit into the middle ground.

Whilst it would be nice to think that total satisfaction could be achieved, this is unlikely because the survey showed people with very strong but opposing views on a number of subjects. An example of this related to the geometric chuck article, where a few spoke very highly of it whilst a similar number were very much opposed to its being included.

I hope you will have found this publication of the survey results, together with comments, interesting and that you feel it will, in the long run, prove beneficial to the magazine.

I will be retaining all your comments on file (as I do any received by letter) and will always be pleased to hear from any reader, whether it be with requests, complaints or even praise!



1: The sizes of filing rest described in this article seen here together to show the comparison.

FILING RESTS

Filing work in the lathe when it is rotating is a habit definitely to be discouraged. It is a dangerous practice in many ways, but mainly because there is the obvious possibility of the file slipping and one's hands being caught on a rotating chuck. Then there is the possibility of a sleeve catching in the chuck and causing injury as it tightens up with the rotation. Apart from the danger to oneself there is a distinct possibility of damaging or destroying work with a file, as there is little control over the movement of the tool if the lathe is running.

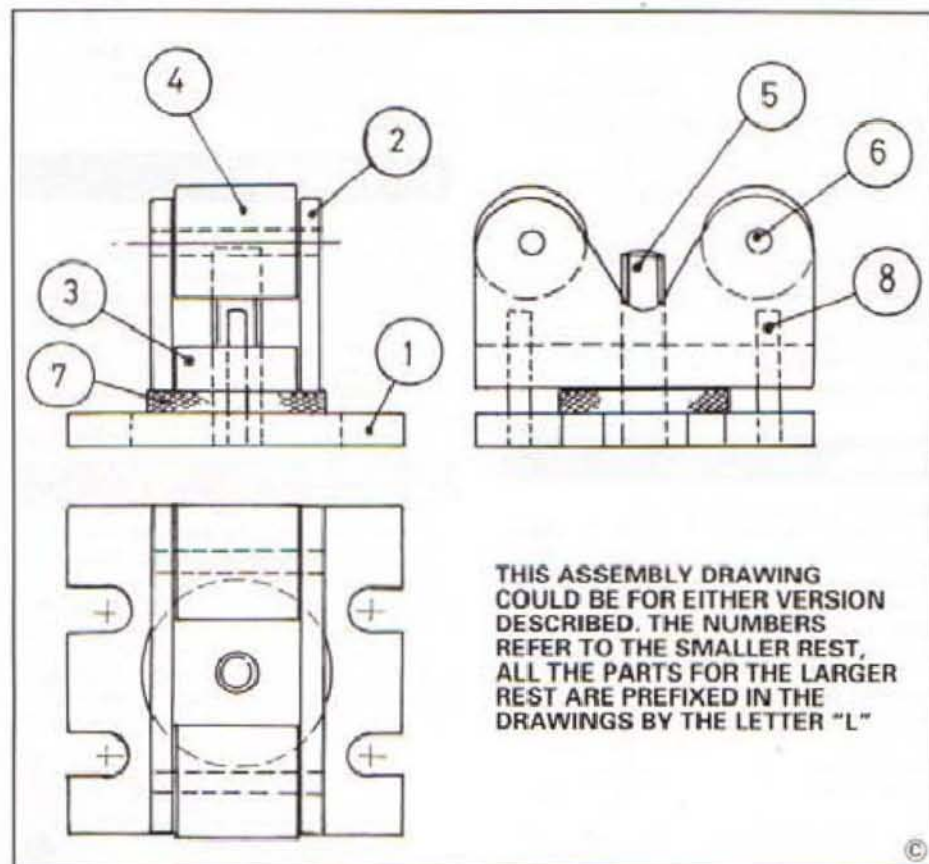
Filing work in a lathe that is stationary is a different kettle of fish altogether. There are many occasions where such an operation is desirable, and unless you own a small milling head or similar item then I

A request from a reader has prompted us to publish this filing rest article, taken from Stan Bray's book *Making Small Workshop Tools* and published by Argus Books. Even in these days of more access to milling facilities, these are still useful items to have available, frequently being quicker than setting up for a milling operation

would go so far as to say that the operation is a necessity.

Getting work even and flat when it is held in a lathe is not an easy task, and if more than one flat needs to be put on a piece of work then it becomes even more difficult. We need some sort of guide for the file, and the headstock locked in the required position. The latter can be done by simply tying the belt so that the mandrel cannot rotate. Getting the file level and flat can be done by the simple means of

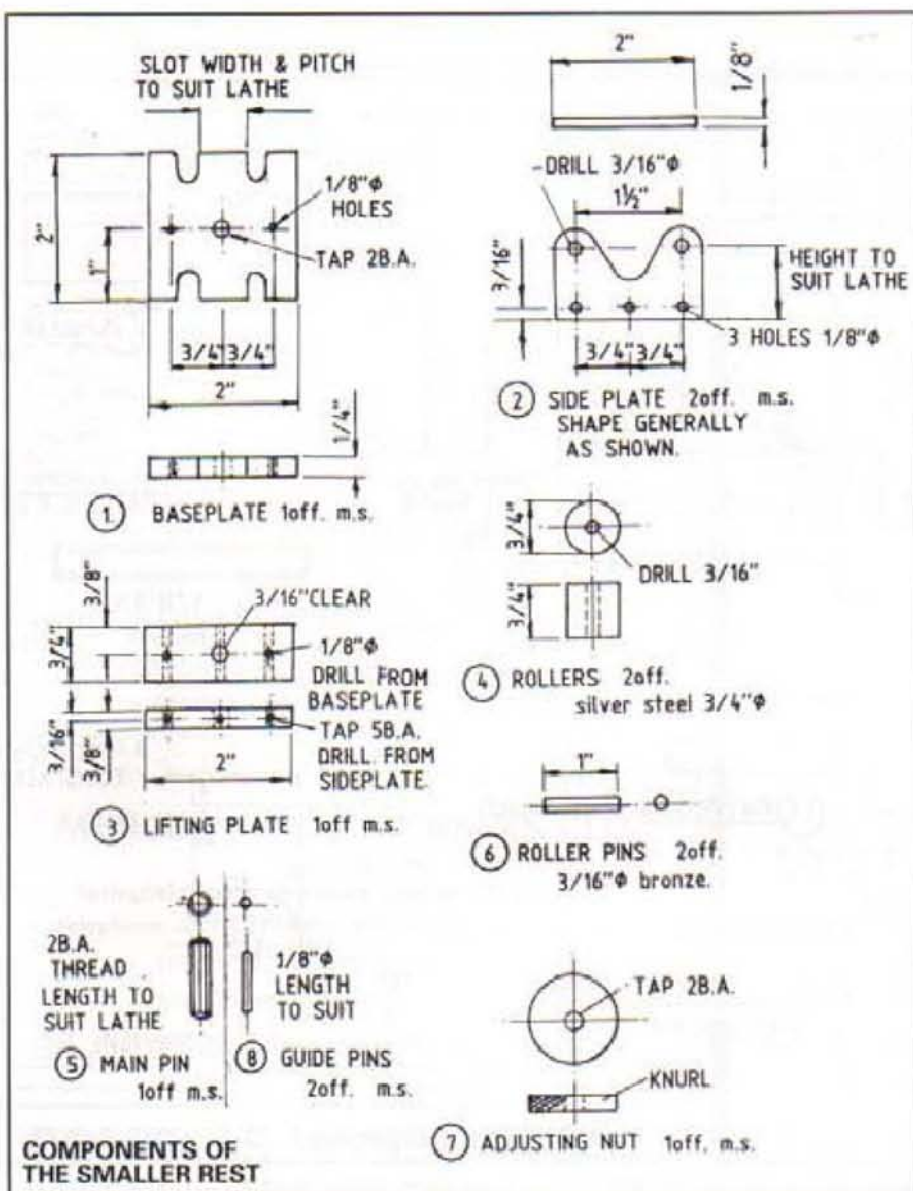
putting a piece of wood on either side of the work and using that as a guide. This works quite well as long as you have sufficient lengths of wood to be able to keep changing them as the height of the flat being filed gets lower and lower. Better still, therefore, is some sort of a rest that will allow a minute adjustment with the work as it is brought to the size required. If we can actually regulate this adjustment to the amount we require then that is even better as we can use it to measure the amount being taken off. The little rest that I am about to describe will do this for you, and although suitable measurements are given these can be altered in proportion to each other to suit individual lathe sizes as required. (In this new reprint from Stan Bray's book, two sets of dimensions are given: the smaller [from the book] will suit Unimat, Toyo or similar, whilst the larger will suit typically Myford series seven lathes. Ed.) As shown it is suitable for the



THIS ASSEMBLY DRAWING COULD BE FOR EITHER VERSION DESCRIBED. THE NUMBERS REFER TO THE SMALLER REST, ALL THE PARTS FOR THE LARGER REST ARE PREFIXED IN THE DRAWINGS BY THE LETTER "L"

QUICK TIP

This tip is a very old and well known one, but I feel sure there are many beginners who will be unaware of it, and benefit as a result. If the expense of a cast iron surface plate cannot be justified, or permanent space cannot be allocated on the bench for such a heavy item and which for many would be too heavy to move to the bench each time it was used, then in this situation a much cheaper and lighter alternative is a small sheet of plate glass, say a minimum of 1/4 inch thick. A local glass merchant should be able to supply a suitable piece cut from scrap. A shallow wooden tray should be made complete with lid to store it in. It is worthwhile paying a little extra to have the edges ground to avoid injury from sharp untrimmed edges. For a luxury finish a bed of felt below the glass will give greater security.



smaller type of lathe, but can also be used with larger ones either by making the base thicker or by using packing pieces underneath.

We will start with what I call the lifting plate. This is made from a piece of mild steel plate about $\frac{3}{8}$ in. thick and $\frac{3}{4}$ in. wide, although if you want a slightly wider rest it could be 1 in. width. It needs to be 2 in. in length. The ends should be squared up and personally I prefer to do this in the four-jaw chuck, but filing will do. Coat with marking fluid on one of the wider surfaces and scribe a line centrally along it. In the exact middle make a centre punch mark and then, using a pair of dividers for marking off, make two more $\frac{3}{8}$ in. either side of it. Drill all three $\frac{1}{8}$ in. diameter and remove the burrs.

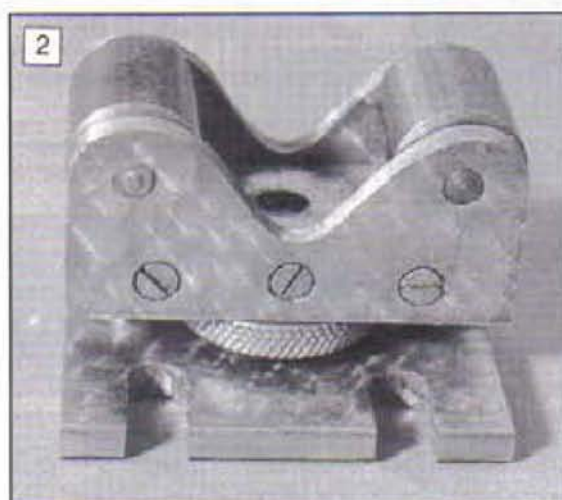
Next we come to the base and this is made from a piece of mild steel 2 in. square, and $\frac{1}{4}$ in. thick. Using a good cyanoacrylic adhesive such as Perma-Bond C4 stick the lifting plate centrally along the base, and when dry drill through with a $\frac{1}{8}$ in. diameter drill. Separate the parts and open out the centre holes in each, the base to tapping size and the lifting plate to clearance. I would suggest $\frac{3}{8}$ in. x 40 TPI as these give an adjustment that can be measured. However, if you do not have the right size taps then any $\frac{3}{8}$ in. thread, British or American, or a 2BA will do. The odd thread numbers per inch will, however, make height measurement rather difficult.

The base can now be tapped to the selected size.

The side plates can be of $\frac{1}{4}$ in. mild steel, and one should be coated with marking fluid, then the five holes marked off as shown on the drawing and punched. Stick the two plates together and drill through all five holes with a $\frac{1}{8}$ in. drill. Separate and remove the burrs. Next carefully stick one side plate either side of the lifting plate, and when dry drill through with the same drill. Separate and open out the three holes in the bottom of the side plate to $\frac{1}{8}$ in. Bolt the two plates together through these three holes and open out the two top holes to $\frac{3}{8}$ in. diameter. This should ensure that they are lined up properly.

Two rollers are now turned to size; they need to be bored to take the pins and faced off to length. There are two schools of thought on these rollers, one that they should be hard, to prevent them wearing and the other that they should be soft to prevent the files wearing! Personally I feel that as they will rotate with the file they should be hardened and therefore make them from silver steel; get them to red hot (the colour of a boiled carrot) and drop them in water. If I was keeping them soft then mild steel would be my choice of material. Two pins will have to be made for them to run on and these are best made from bronze as this will virtually prevent wear. These pins will eventually be held in place in the side plates with retaining compound so they just need turning to length.

The rest is adjusted by means of a nut which fits between the base and the lifting plate. It should be drilled and tapped and at the same time knurled. If using threads that allow measurement of height adjustment it may be as well not to knurl it but to divide it equally in four (using the chuck jaws if you do not have a dividing head) and drilling a small hole at each point of



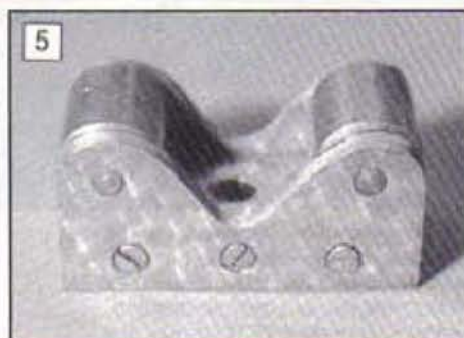
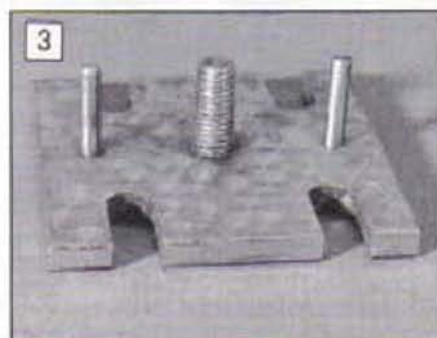
THE SMALL REST

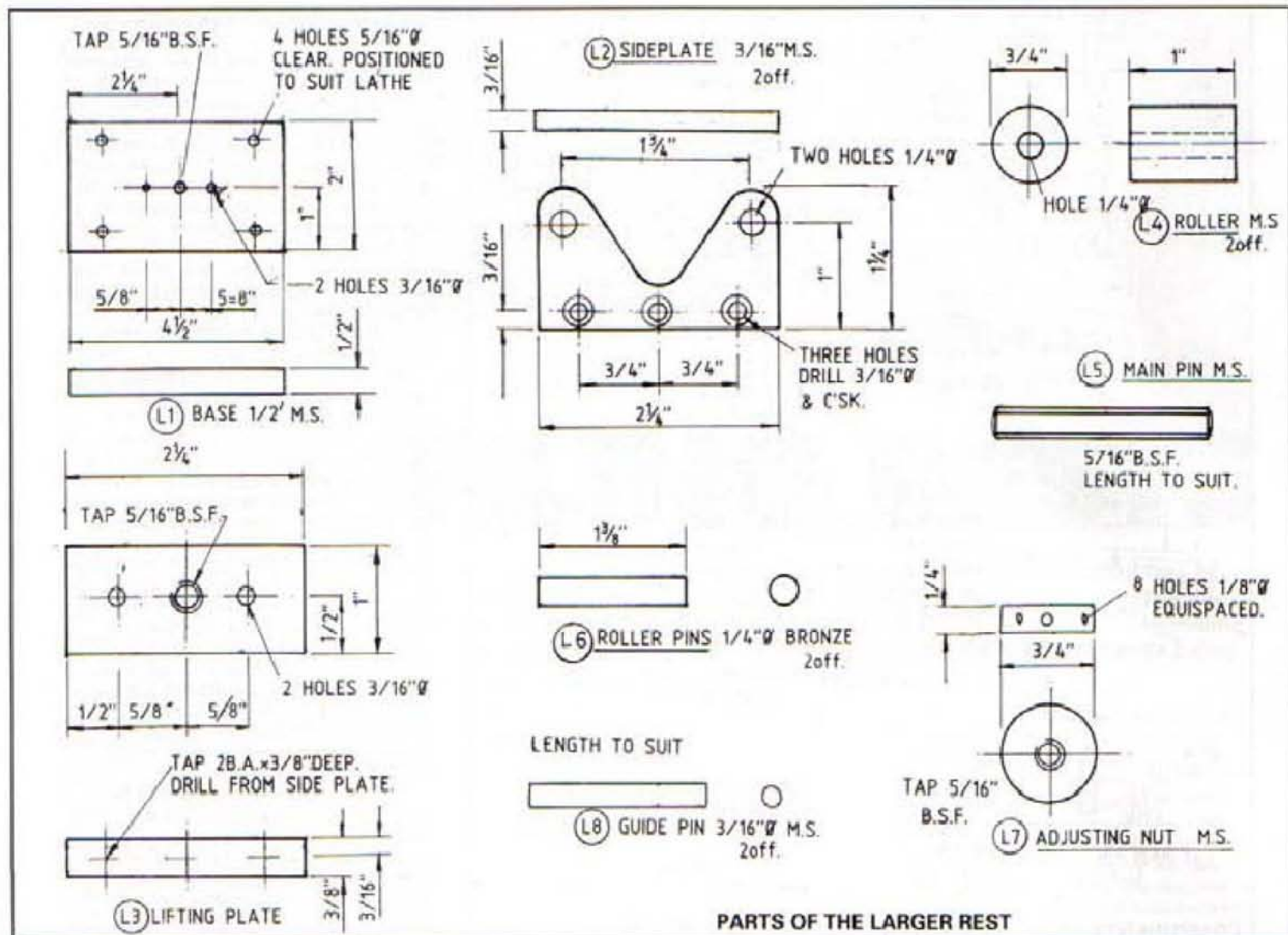
2: The complete assembly; this one is fitted with a knurled adjusting nut.

3: The base of the rest, showing the guide posts and jacking screw.

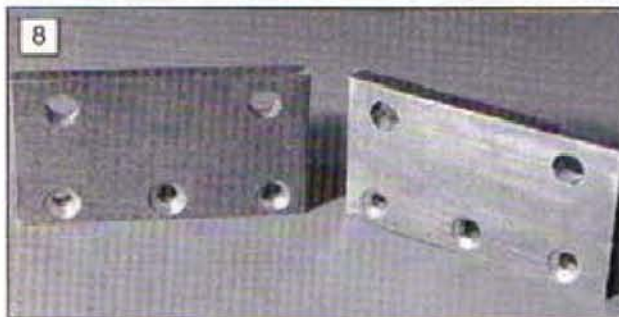
4: This is the jacking nut.

5: The file guide roller assembly.





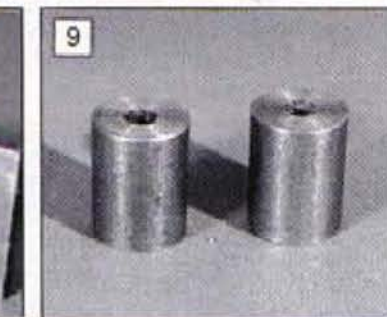
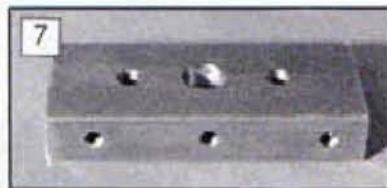
PARTS OF THE LARGER REST



division, say 1/8 in. diameter. A small rod can be put in these holes to turn the adjuster round, and the amount of height movement gauged by their position. For example, if using a 40 TPI thread one

THE LARGE REST

- 6: Note that the jacking screw is fitted with tommy bar holes on this version.
- 7: The lifting plate on the guide roller assembly.
- 8: The side plates of the same assembly, seen here prior to shaping.
- 9: The guide rollers; choice of material is that of the constructor.



complete revolution will lift the adjuster 0.025 inch.

Slots must be put in the base, and these will have to suit your lathe. Ideally two slots are best as they make fitting easier,

but one will do if this suits your requirements. The alternative is to drill holes in suitable places so that it will bolt to your cross-slide. Before finishing with the base we need two guide pins, which are just lengths of mild steel to prevent the rest moving sideways when being adjusted. These can be held in position in the base with Permabond 168 or similar retainer. We also need the screw on which the adjuster is to run and this is a plain piece of studding of the correct thread, held in again to the baseplate with the retainer.

Finally it is just a case of assembly and how this is done should be clear from the drawings. The lifting plate will of course need to be tapped to take the screws that go through the side plates, the side plate holes having been countersunk so that the screws do not stick out and get in the way. It is possible to make different types of rollers to take half-round or round files etc., but this is a matter of individual requirement. Once the idea is implanted variations become easy and a matter of personal preference.

Postscript

Stan's book *Making Small Workshop Tools* can be obtained from: Argus Order Dept., Combined Book Services, 406 Vale Road, Tonbridge, Kent TN9 1XR. The price is £7.70 including postage, cheques payable to Combined Book Services (credit card orders Tel. 0732 357755). Send for a catalogue showing the full range of titles available in the 'Workshop Practice' series.

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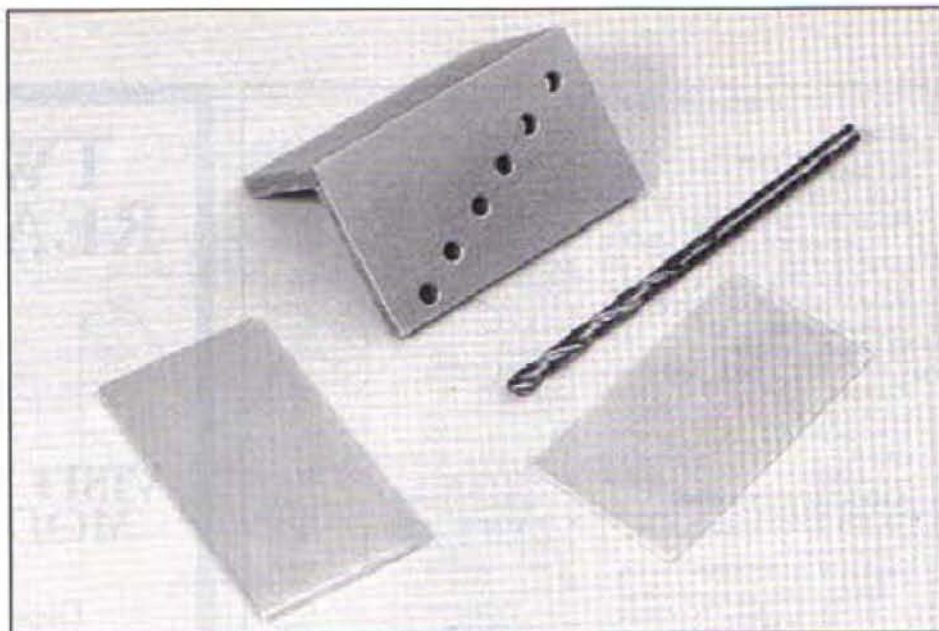
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Mr Harries of Icomb, Cheltenham proposes some useful methods for cross drilling cylindrical parts, some without any other aid than the vice used to hold the component

The drilling of a diametral hole through the side of a cylindrical part is not always successful when the part is marked out separately, and then positioned in a machine vice or V-block for subsequent drilling. It is better practice to first clamp the part in a machine vice, then mark it out and drill the hole, while so held. **Fig.1** shows three ways how this can be done with a jenny callipers, on various cylinders.

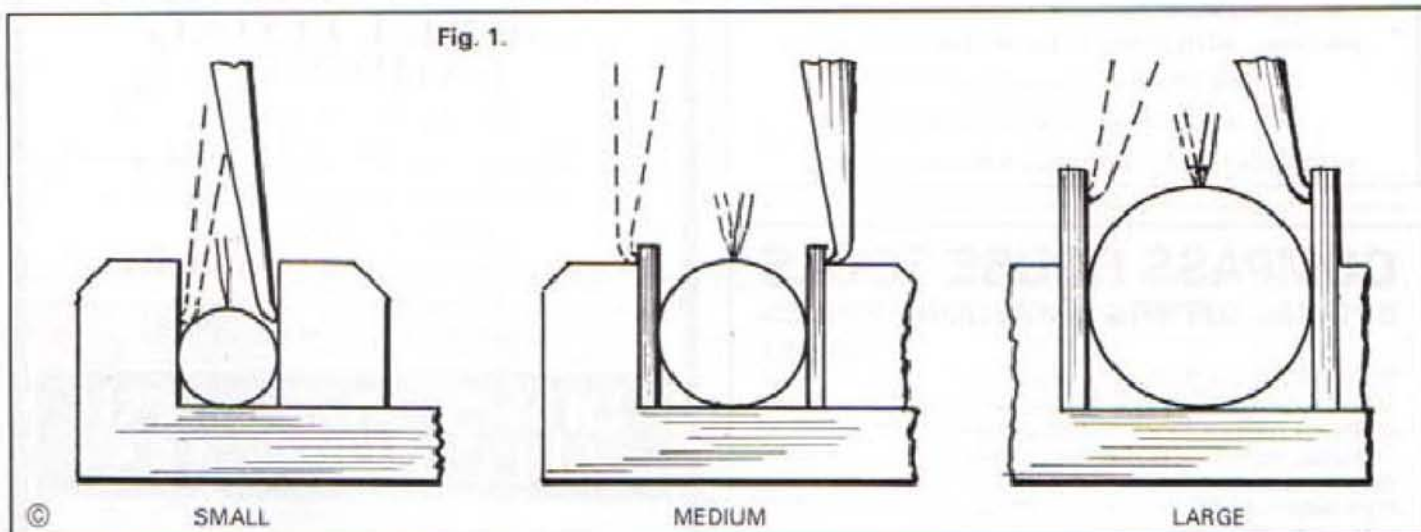
Nothing looks worse than a hole running off the diametral line of a cylinder. A typical part calling for a cross hole is the tommy bar screw, **Fig. 2**, and the jig



The completed jig, together with two small plates, one $\frac{1}{8}$ in. and the other $\frac{1}{2}$ in. thick. By using these as packing between the inside face of the angle and the job, the jig can cope with cross-drilling in increments of $\frac{1}{8}$ in., even though it is drilled at $\frac{1}{4}$ in. steps.

CROSS DRILLING JIG

Fig. 1.



recommended for holding and drilling is seen in **Fig.3**. The blocks A and B are clamped together with a slither of thin sheet metal between them. The acceptance hole for the job, the drill guide hole and the

holes for the pair of clamping screws C are then marked out and drilled. To the back of B only is soldered a stop plate D to locate the job endwise. The jig allows for the easy removal of the job after drilling when there is a certain amount of burr on the exit side of the hole.

Bigger cylindrical sections can be cross drilled by clamping an angle section jig to them – such a jig enabling holes at right

Fig. 2.

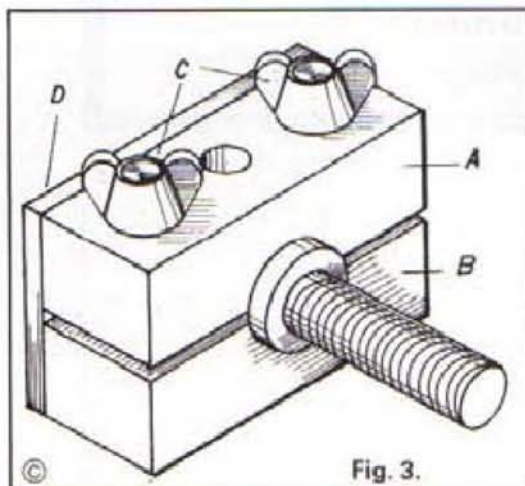
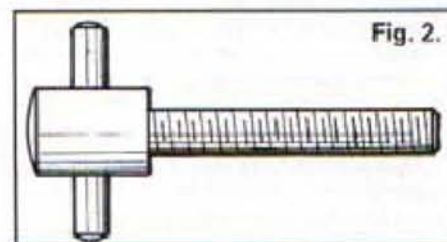
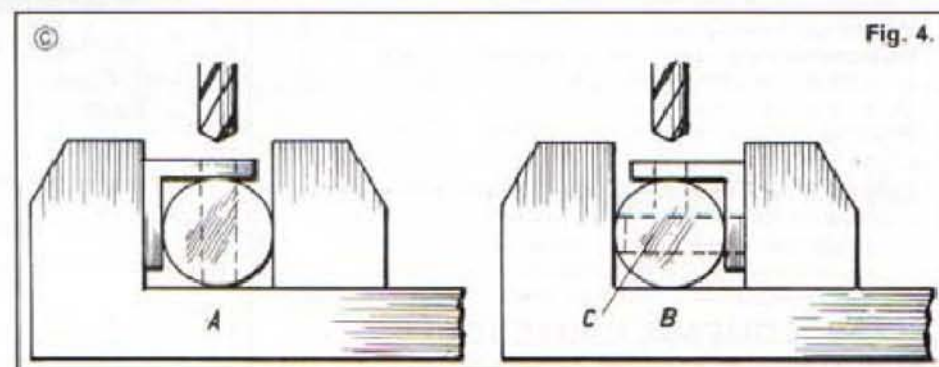


Fig. 3.

Fig. 4.



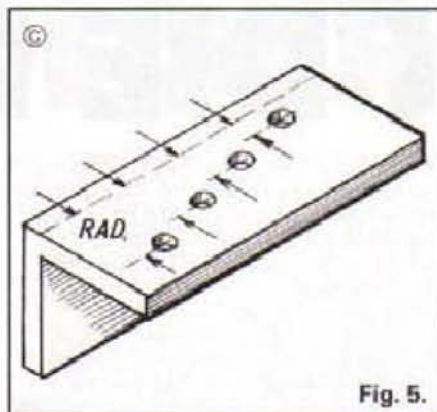


Fig. 5.

angles to be drilled is seen in Fig. 4. The jig is clamped to the job in a machine vice as indicated at A, then after drilling the

required holes through the top face, the whole assembly is turned through 90 degrees to position B for drilling the holes at right angles. The first hole should be pegged at C to maintain proper alignment.

Universal Jig

This angle jig can be developed into a universal pattern, to drill a range of standard rod sizes by setting out a series of holes, the radii measurements away from the inner face of the angle, Fig. 5, also shown in the photograph. When a jig drilled hole has to be opened up, after the job has been released from its jig, fresh alignment of the job will be necessary. This can be done by lowering the drill once more into the job while free, and then tightening up the machine vice while the job is so aligned. The larger size drill can then be run through.

A collar drilling jig

Short cylindrical components with an axial hole, like collars, can be cross drilled with the angle jig of Fig. 6. A is a piece of angle steel of big enough section to rest on the vice base when the job B is located on the steel peg C. The horizontal arm of the angle may have to be shortened to clear the right hand vice jaw. To ensure that the drill passes through the job on a diameter, the common marking out line around the angle for the guide hole and the locating peg, must be at right angles to the edge of the angle that rests on the vice.

Precision

Where the greatest precision is called for in cross drilling, then a disc with an accurate hole in the centre should be turned to the same diameter as the job when it can be clamped over it as in Fig. 7.

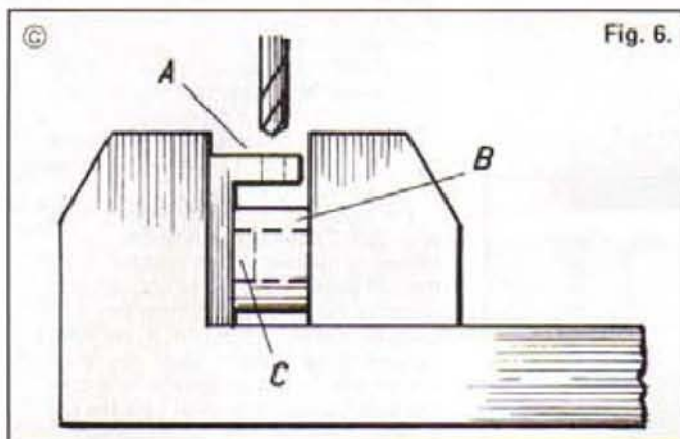


Fig. 6.

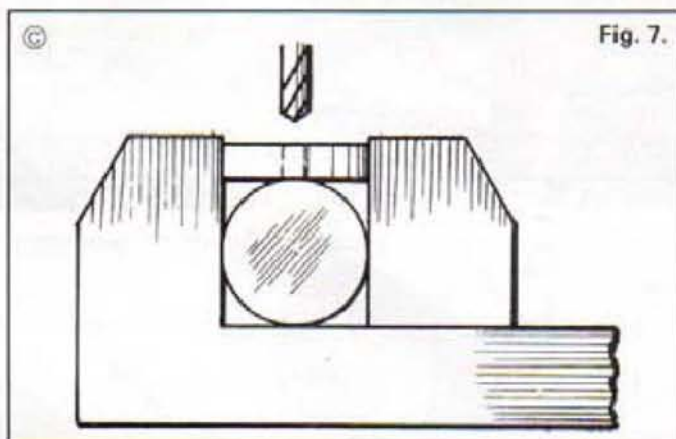


Fig. 7.

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A TAILSTOCK DIE HOLDER

As Dyson Watkins states in this article, if you don't already possess a tailstock die holder, then now is the time to make this invaluable addition to your lathe accessories

If at any time you have been faced with the problem of cutting threads on small diameters which are difficult to screwcut because of their flimsy nature, and which have to be free from drunken thread syndrome, then this little project is a definite must for you. Most readers will very likely have come across this tool at sometime or another, but if you don't already possess one, then now is the time to start make it, and once made, you will wonder how on earth you ever managed without it.

Description

The tool is simply a sliding dieholder supported on a taper shanked arbor held in

the tailstock. Two heads are made which cater for four popular diameters of dies, namely $\frac{1}{8}$ in., 1 in., $\frac{1}{4}$ in. and $\frac{1}{2}$ in. The die in use is held in the appropriate recess by three grub screws, which are carefully tightened so as to compress the die progressively so that the resulting thread ends up at the correct diameter. More about this later. The tailstock must of course be set on centre prior to this operation.

Making

The arbor is made first of all from a length of $\frac{3}{4}$ in. dia. bar. One end is faced and centred, then gripped near one end, and supported at the other by the tailstock

centre. A light cut is then taken along the bar to true up its surface. Several methods are suitable for machining the taper, and the use of a dial indicator is probably the easiest, so this method will be described next. The taper in terms of the change in radius per inch length needs to be calculated, or read from tables, such as Zeus, which most constructors seem to have in their possession. Set over the compound slide (or top slide) as accurately as possible to half the included angle of the taper. Set up the dial indicator in the toolholder, so that it rests on the skimmed part of the bar. If the compound slide is now advanced a distance of 1 in. then if the angle is correctly set then the dial indicator will move through a distance equal to the sine of half the included angle. To save anyone the bother of thumbing through tables or hunting for a calculator, the dial indicator travel corresponding to Morse taper No.s 1, 2 and 3 are given in the table at the end of the article.

For those less fortunate constructors who do not have a dial indicator, the following method is also suitable. Set up the half angle as before as accurately as possible. Next set up a cutting tool in the toolpost and wind it in until it just makes contact with a 0.025 in. feeler gauge which is held against the workpiece. Withdraw the feeler gauge, and wind back the top slide until the tool just makes contact with the work. The distance traversed should be 1 in. as in the previous method. It is worth mentioning that the sine of the half angle is almost the same as the tangent because the angle is so small, so if anyone wishes to check the dimensions using trigonometry, it will be evident that this fact is quite true for the degree of accuracy required.

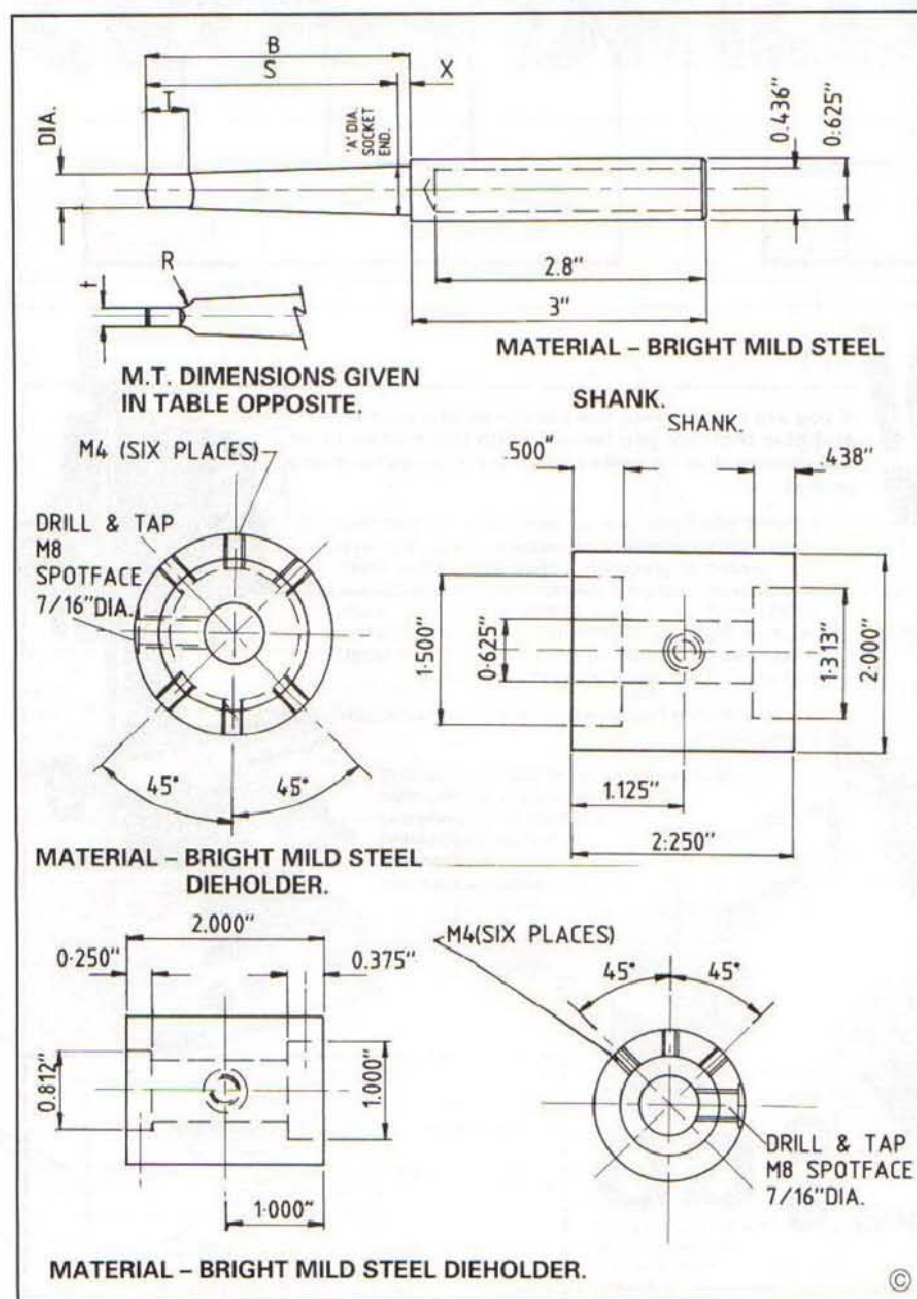
Yet a third method, which is perhaps cheating just a little, is to set up a drill having the required size of taper shank between centres and set up the compound slide to the same taper, either with a dial indicator, or with feeler gauges. Choose whichever method suits best.

Having set the angle accurately, machine the taper according to the chosen size and then, after removing the chuck, mount the newly machined taper in the headstock taper. Then machine the parallel portion of the arbor to 0.625 in. dia., having first drilled the hole down the centre. The hole incidentally will be found to be very handy when making long screw threads, as they will have the space available to project into the hole.

Dieholders

It is immaterial as to which dieholder is made next, as the methods used are the same for both sizes.

If bright bar is used which is clean and undamaged, set it up in the four jaw chuck to run true. It can with care be set up in the three jaw chuck if the latter is reasonably accurate and the jaws in good condition. Face the end of the bar, and drill out the waste as far as possible so as to leave just a little for boring out the 0.625 in. centre hole. If a 0.625 in. reamer is available, then it would be worth reaming the hole, in



OLDER

which case the dieholders should be made before the arbor, and then the corresponding dimension on the arbor could be machined to the desired degree of fit using the dieholder as a gauge. Having bored out the centre hole to give a good sliding fit on the arbor, proceed to bore out the recess for the die. It is a good idea to use a die to test the fit, as the die should not have to be entered into the recess with any degree of force, which would of course have the tendency to close the die in use and make it cut an undersized thread. Next reverse in the chuck and bore out the other end to suit the corresponding die.

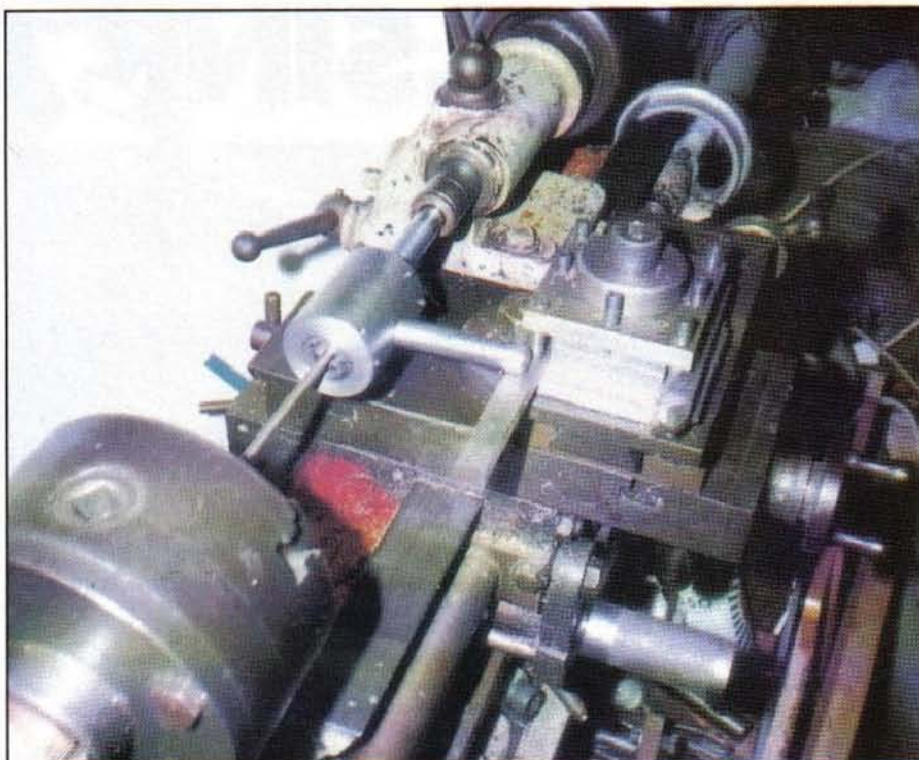
The tapped holes for securing the die need to be marked out next, and it is worth reflecting at this stage as to the most convenient point on the holder to place them. In use, the peg fitted into the side of the holder will generally be horizontal, projecting towards the turner and supported on a steady held in the toolpost (At any rate, that's how I do it), so for ease of adjustment, it is most convenient to position the screws on the top, which means that for the holder on the other end, the screws will be in the opposite side! It does not matter however if they are on the same side, it only means that the holder has to be turned over for adjustment; no sweat! The tapped holes are 45 deg. apart, set in from the mouth of the recess by a distance equal to half the depth of the recess, which is also half the thickness of the die. The sizes of screws used are in no way critical as long as their points mate up with the recesses in the dies used. I used 4 B.A. on mine as these were available. Next drill and spotface the hole where the peg fits into the side. A suitable thread size would be 5/16 in. B.S.F. or M8 if preferred.

The two pegs are made to suit the lathe, being made longer if required to suit the space available. Generally about 3 in. will be found suitable.

Use

As far as use of the tool is concerned, little needs to be said but, at the risk of boring the knowledgeable reader, a few words of guidance are offered to the novice. Do take the trouble to ensure that the tailstock is accurately centred before using the tool. It is better to take several cuts than one heavy cut in arriving at the final diameter. Fine threads used in the adjuster screws will make for a more manageable adjusting procedure. Do use cutting lubricant such as 'Treflex' or 'Rocol R.T.D.' compound which will make your dies last much longer as well as imparting a better finish to the cut thread. Help the die to start the cut by machining or filing a small lead chamfer on the end of the bar to be threaded.

When long threads need to be cut, then they can be produced using the lathe under power. Be sure to engage back gear and the lowest speed. Short threads can be cut by pulling the chuck round by hand with the spindle in neutral if necessary. If using power, adjust the support bar which is held in the toolpost so that the diehead drive peg runs out of engagement just as the correct length of thread is approached. The



set up for the operations can be clearly seen in the photograph. A point to mention, which is probably obvious, is that the length chosen for the drive pegs should be such that the pegs are able to clear the cross slide when allowed to rotate after disengagement from the support bar.

Another point which I'm sure someone else will be certain to mention if it is not mentioned now, is that ideally the part of the drive peg which contacts the support bar should be flat. The reason for this is to ensure that just before disengagement, any tendency for a round surface (on the peg) to force forward and put an additional side load on the die holder is obviated. The peg in the photograph has not been squared off at the end. I thought I'd just mention it! All that remains to say is: press on, and enjoy this little project.



QUICK TIP

Although we all admire machined surfaces, many items constructed in the home workshop will benefit from enamelling using brush or spray. The advice "many coats and rubdown between" is sound but the time taken mounts up. Gently baking the job between coats accelerates the process and helps to build up a solid hard wearing paint film. An infra red lamp, of the sort sold to treat bad backs and poorly knees is ideal. I use a pretty orange job from Boots, which has two short silica elements and can be directed strategically on the painted surface.

J. Jennings

Morse taper shank details

M.T. NO.	B	A	T	t	R	TANG DIA.	S	X
NO. 1	2.562	.475	.375	.203	.187	.343	2.437	.125
NO. 2	3.125	.700	.437	.25	.25	.531	2.937	.187
NO. 3	3.875	.938	.562	.312	.281	.719	3.687	.187

AN OILSINK CUTTER



In this short article by John Jennings, he explains the benefits of a spherical oil sink in clock plates, over using conventional countersinks. He then suggests making this little tool in a range of sizes.

Compared with the standards of precision engineering, clockwork runs on the basis of fairly free fits and basic bearing techniques. Clock designs with ball races are rare and probably produced by the amateur clock maker; the benefits are probably more in the reduction of long term wear on heavily stressed arbors, especially in weight driven clocks. The standard bearing is a hole in the clock plate, ideally hardened by a smooth broach, with the lubricant retained in a small depression around the pivot hole. This is the oil-sink. **Fig. 1.**

An oil-sink, although simple in concept, needs to meet certain criteria: it must have as big a volume as possible, it must retain

the oil and not let it drain out and over the clock plates. A circular cross section is ideal, and better than the cone shaped depressions produced by an ordinary countersink bit, give a small volume and a shallow oblique lip. The usual range of countersink size is also large for the purpose, and the handy substitute a regular twist drill is even worse in shape.

Purpose made oil-sink cutters are available, but are not difficult to make and in a wider range of sizes. There is no reason not to make bigger sizes than in the table. The general arrangement is shown in **Fig. 2.**

A hard metal disc, rather like a flat edged glass-cutter wheel, is freely

mounted in a holder that can be rotated back and forth between the fingers. The hard brasses used for clock plates cut freely with tools of zero rake, and providing the cutter discs are thin enough, the right angled "tool edge" will cut freely.

The cutter discs are made from polished silver steel, preferably of the same diameter as the finished disc. It would be quite possible to turn a number of steps on a length of silver steel, to provide a number of sizes from one length. It is essential however to polish each step free of scratch marks, or they will be replicated in each oil-sink that you cut! Carefully drill the silver steel about 1 mm diameter and deep enough to produce the required number of discs. Part-off tiny discs about 10 to 15% longer than the finished thickness. A small thin parting tool ground from a short end of $\frac{3}{8}$ in. or 5 mm H.S. tool bit is ideal. Another useful wrinkle here is to grip a short length of thin wire in the tailstock drill chuck and advance it into the drilled hole.

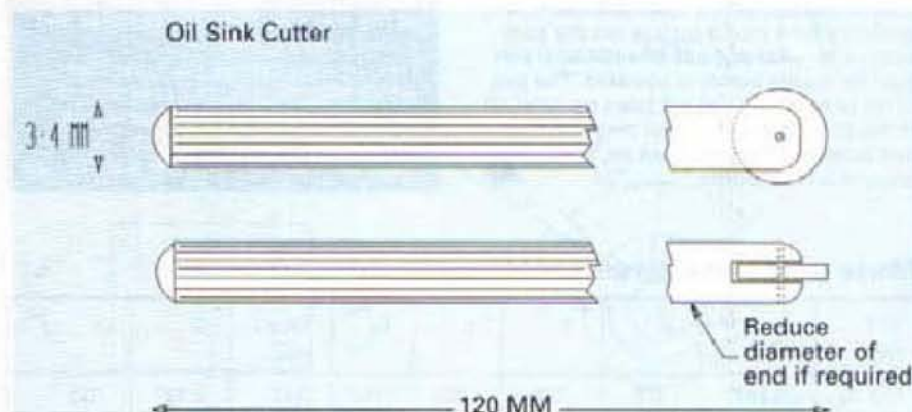
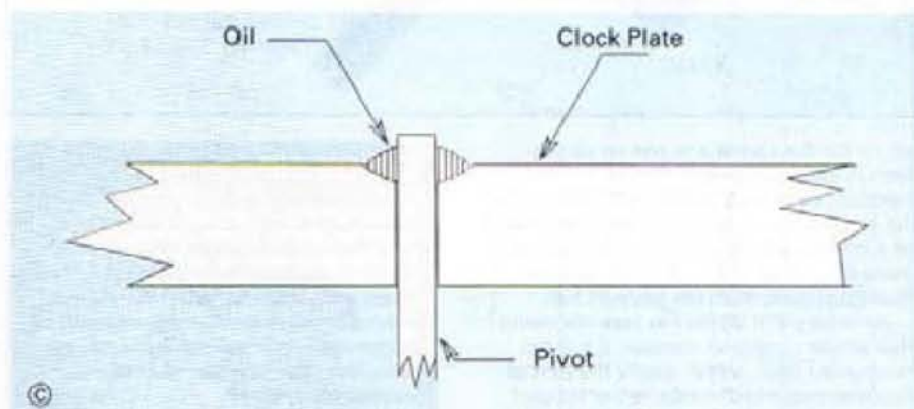


On parting off, the freed disc remains on the wire and does not fall away and become lost.

The tiny discs then need grinding and polishing on a well lubricated oilstone until any scratches are removed and the disc has two smooth faces and a sharp edge. A small piece of wood or plastic with a 1 mm diameter pin sticking just proud of the surface is useful in handling the disc in the smoothing process. Finally, bring each disc quickly to red heat and quench in water. A final polish on a smooth oilstone will give the final finish. Tempering the discs is probably unnecessary and certainly unpredictable.

Construction of the handle is fairly self evident. You may want or need to reduce the diameter at the business end to allow the smaller discs to clear the stem. An easy and effective way of finishing the stems is to pull all but an inch or so through a fold of coarse glass paper, 40 grit is not too coarse, this will give a good grip and appearance to the finished tool. If you use the interchangeable compendium sets of miniature screwdrivers and nut runners that are available, you might alternatively make much shorter handles with ends turned down to fit the common handle in such sets.

Finally, assemble the bits, Loctiting the cross pin or gently riveting the pin ends, the disc should be free to rotate in use.



Diameter	3m	4m	5m
Thickness	0.2m	0.35m	0.5m

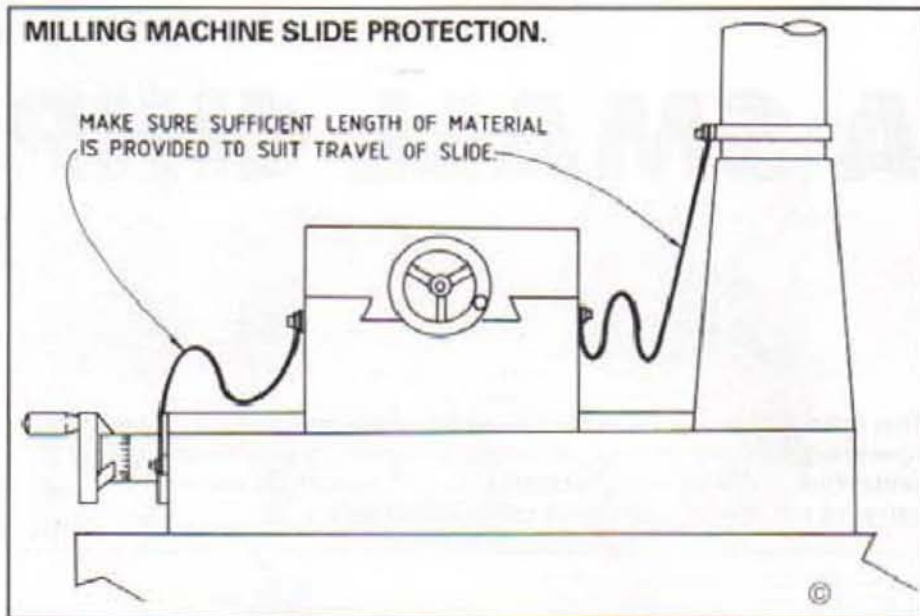
MILLING MACHINE SLIDE PROTECTION.

This simple addition to your drill/mill will greatly ease the problems of keeping the lower slides clean and in good condition

I soon discovered when using my new drill/mill that it had one minor but irritating weakness. This situation being that much of the swarf created would fall onto the lower slideway, both in front and behind the table, and was difficult to keep clean.

Whilst a form of extending shutter was included to cover the lead screw, this did not function very satisfactorily, and allowed swarf also to get into the leadscrew area.

Cleaning the machine was rather a chore, and as a result did not get done as often as it should. Even if it were to be done regularly, swarf would still be resting



PROTECT THAT SLIDE

on the slide for some of the time, with the possibility of smaller particles getting into the slideways.

To improve the ease of cleaning the machine, I must admit, had higher priority. The only practical solution appeared to be the inclusion of an apron, as is frequently provided on many larger industrial machines.

The main problem was behind the table as this was the most difficult to get at and also had the greatest problem with

protecting the lead screw.

Even so it was decided to provide aprons both in front of, and behind the table. Observing illustrations of machines now being supplied indicates that an apron is standard practice at the rear, but is not included in front.

The material

The material requires to be sufficiently flexible and yet also rigid enough to maintain its position, particularly when

being swept clean. The material used was a piece of plastic material normally used to cover drawing boards. This is made in a three ply formation of various plastic materials, and is about 50 thou. thick.

It had not been fully realised initially, but the channel formed collected the swarf and, together with the rigidity of the material, made cleaning with a small hand brush extremely simple.

Obtaining the same material for most will not be a possibility, though with the rapid demise of the drawing board, in favour of CAD, there must be plenty being thrown away.

A good quality piece of vinyl floor covering should be adequate, and an offcut should easily be obtained from the local suppliers scrap bin.

Having decided to make this part and obtained suitable material, it remains to fix this to the machine. No existing fixings for other purposes are likely to be able to double for this requirement, and so some additional holes will be required.

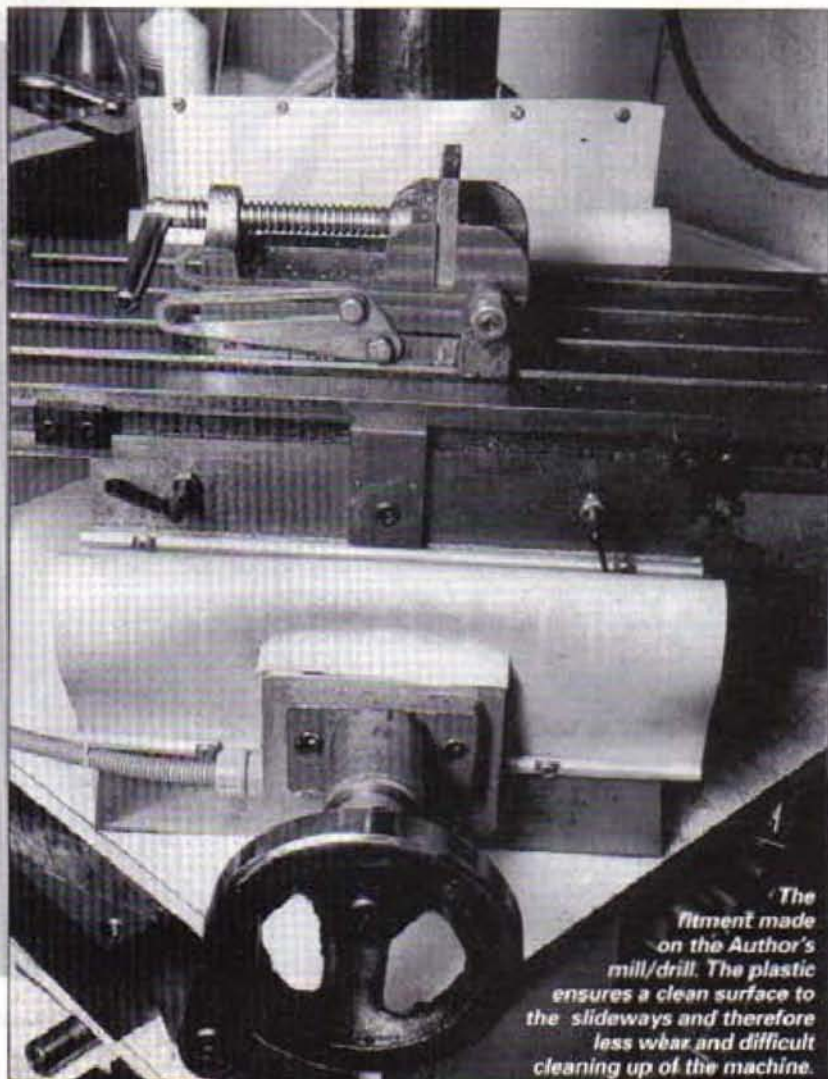
To make the edge being fixed more secure, a metal strip was included. In view of a large amount of $\frac{1}{8}$ in. dia. aluminium being available, this was used, as will be evident in the photograph but some $\frac{1}{2}$ x $\frac{1}{8}$ in. steel strip or similar would be suitable.

It was necessary to drill and tap holes at the front both in the base and the part between the base and the table. This presented no problem as it was easily accessible.

The rear cover had to be fixed to the rear of the same moving casting, and then to the pillar using a bar and a saddle clamp. Drilling the rear was rather more difficult in view of it being rather inaccessible, making it difficult to get the required pressure, as all the holes had to be drilled with a hand drill.

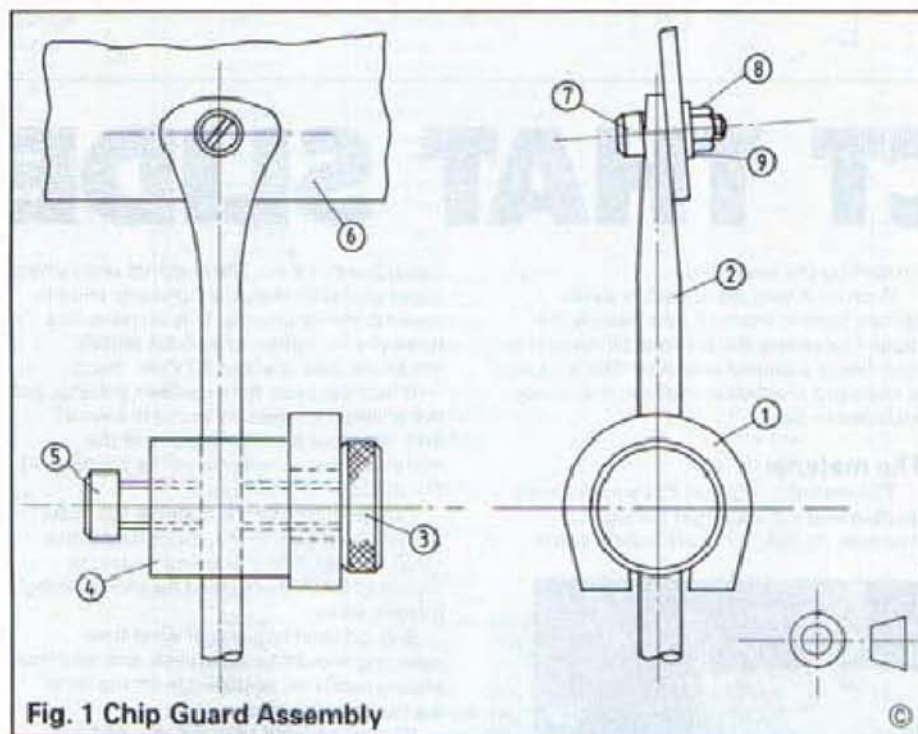
To make the covers wide enough to ensure that they protect the slides adequately, about 1 in. overlap each side should be considered a minimum.

With the covers completed, cleaning these parts of the machine could not be easier, and the result is well worth the effort involved.



A SMALL CHIP GUARD

This little chip guard from Mr FJ Loader could improve the comfort of operating your machinery, but more important give essential safety protection. Even so, eye protection should always be worn when carrying out operations which cause swarf to fly



ready made or needed very little alteration.

The main parts are shown in Fig. 2, and the only one which needs much doing to it is the boss. I used a piece of $\frac{1}{4}$ in. diameter duralumin cross drilled to take the $\frac{1}{4}$ in. diameter rod. The boss was drilled and tapped at each end so that the rod could be clamped by a screw at one end and the whole assembly clamped to the magnet at the other.

I chose soft aluminium alloy for the $\frac{1}{4}$ in. rod so that one end could be flattened with a hammer. The flattened end was fastened to the shield, item 6, by items 7, 8 and 9 (Fig. 1), which were a 6BA screw, washer and nut. The shield was made from the lid of an old cassette box, they are a reasonable size and just need cutting off, trimming and a hole drilling for the screw. Any transparent material of a suitable size would do if it is thick enough.

None of the dimensions are that critical and there is plenty of scope for experiment with the bits and pieces to find the most suitable lengths and locking methods. The drawings show the guard as I made it for my Unimat 3 but it could be adapted for larger machines.

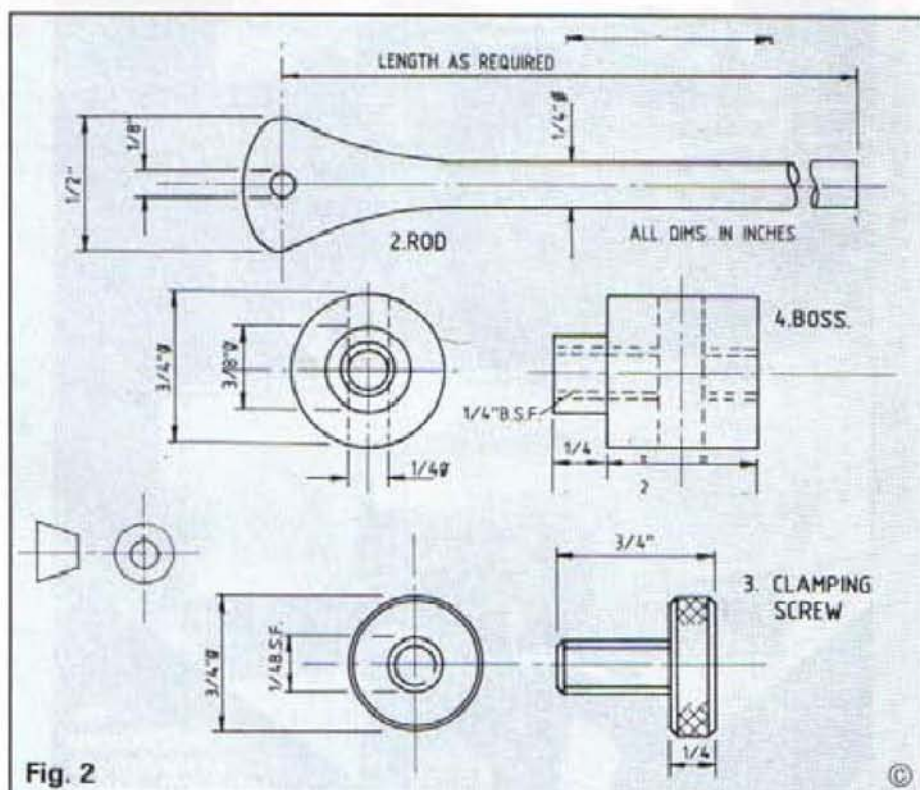
In use it will 'stick' to anywhere on the tool post of my lathe and can be adjusted to the best position quite easily. I used it in the position shown in the photograph. The shield can be made larger or smaller to suit different circumstances. The magnets are easy to find in most hardware shops, or what we used to call ironmongers. The last time I saw one it was an Eclipse with a keeper and listed to lift 2kg. It was priced at £3.10. There was a slightly more powerful button one at £5.65 which will lift 3.5kg. but it would need a different clamping system and the extra sticking power is hardly needed.

It is a useful little gadget to have for the jobs which throw bits of swarf about and it has put the magnet to use where previously it was just gathering dust.

For one of my current projects I needed to machine a bush from hard brass. I had the usual problems, small particles of swarf flying everywhere. My eye protection was adequate but as it was hot and I was doing my machining in the garden, my shirt was open. At intervals I did a little dance when small very hot bits got down my neck.

What I needed was a chip guard, not a big one, but one I could move about to find the best position to block off the chips. A magnetic one would be nice I thought, because it could be moved about anywhere where there was something made from iron or steel to stick to it. Nicer still, I had a small horse-shoe magnet which I'd bought years ago for some long-forgotten reason. All I ever used it for was to find out if a steel was stainless, or sweep it over the floor to find small lost ferrous articles. It was time to make it earn its keep.

It was fairly easy to rig up a simple guard from bits and pieces out of the scrap box. The photographs and the drawings give an idea of what is involved in the making. I put no materials on the drawing because the only requirement is that they are non-ferrous, it makes the machining easier and I was lucky that most were





- 1: The chip guard in use. The reason for using it can be seen spread over most of the lathe.
- 2: The components of the guard.



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Toggle clamps are much used in industry, but apart from the plier type they do not often appear in the catalogues of suppliers to the home workshop, so it is often a case of make your own. In this, the first of two short articles, we offer details of their operation, and a design to make a vertical clamp. Next time we will publish a design for a horizontal clamp.

The toggle action is one that we find in many items of everyday equipment; probably the most common, though now being overtaken by other designs, is the older types of electrical switch.

The toggle arrangement has two main attributes – first, as in the electrical switch, that of locking itself in its operating position, once it has passed its centre position. The other, that it is able to exert a high force as it passes the centre position with only a low force input.

Both these attributes are put to effective use in the engineer's toggle clamp. With this device, very high clamping pressures can be achieved, with only low force required on the part of the operator. Also the clamping action is available very rapidly, of particular benefit if a number of identical parts have to be held.

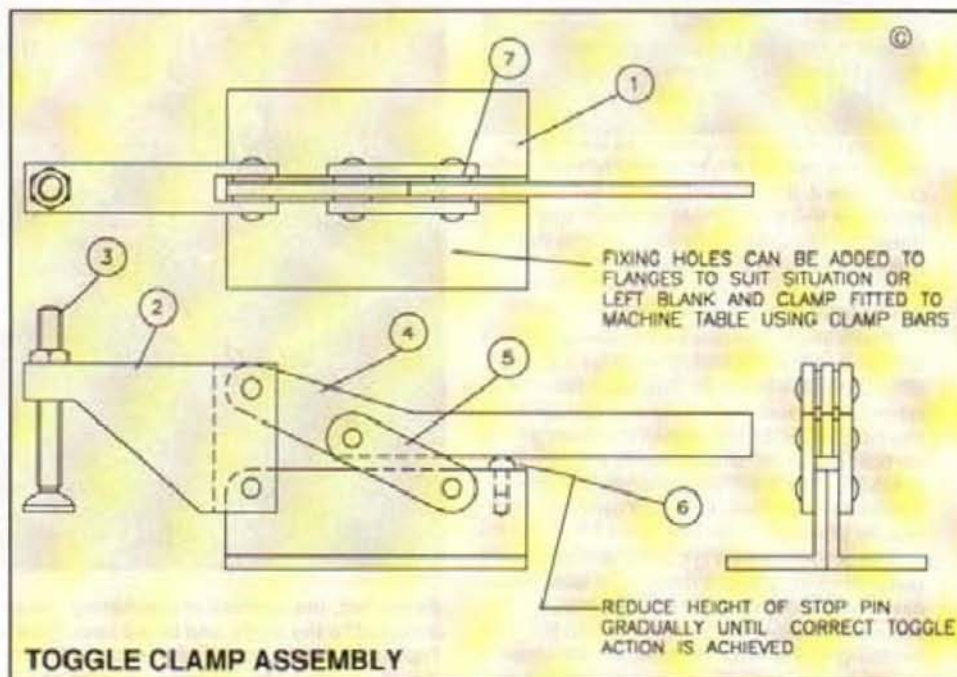
Principle of operation

The resulting clamping force, unlike the vice, is not directly controlled by the amount of force applied to the device by the machine operator, but is dependent on a number of contributory factors as follows.

Ignoring friction, it could be considered that, as the device passes the centre position where there is no movement of the clamping arm but whilst there is still movement of the operating lever, and thus having infinite mechanical advantage, infinite clamping pressure would result. It is obvious that this is not the case, so what limits the value?

If an infinite force was to exist, it would obviously destroy the clamp itself. It is this, of course, that limits the force for, as the

VERTICAL TOGGLE CLAMPS

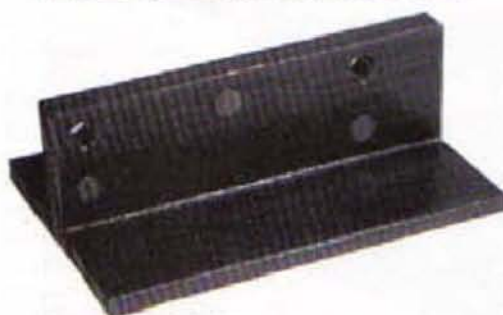


pressure builds up, the clamp will flex and this in effect limits the pressure available. This maximum holding force, though, is still greater than the clamping force that will be available in the latched position.

An essential feature of the toggle action is the fact that it must go past centre to ensure that it locks in the 'on' position. This is particularly important when being used to clamp parts being machined. For, should the clamp vibrate open due to the machining operation, work could be damaged and, more importantly, very dangerous situations could result.

Because of this the clamp must rest well past its mid position. As a result, therefore, the clamp arm will start to return, thus releasing pressure, from the maximum holding force to the actual clamping force obtained.

There are still factors which, more than anything else, govern the force achieved in a given situation, and one of these is setting. The clamp carries a screw type pressure pad which can be adjusted to suit



The assembled base.

the size of item being clamped. With this set so that the pressure pad only just reaches the work piece, when the clamp is operated no clamping force will result.

As the screw is extended more from this initial setting, the force will increase until it reaches a point, where the operator can no longer operate the clamp satisfactorily. The adequate setting will be somewhere between these two extremes.

Limitations

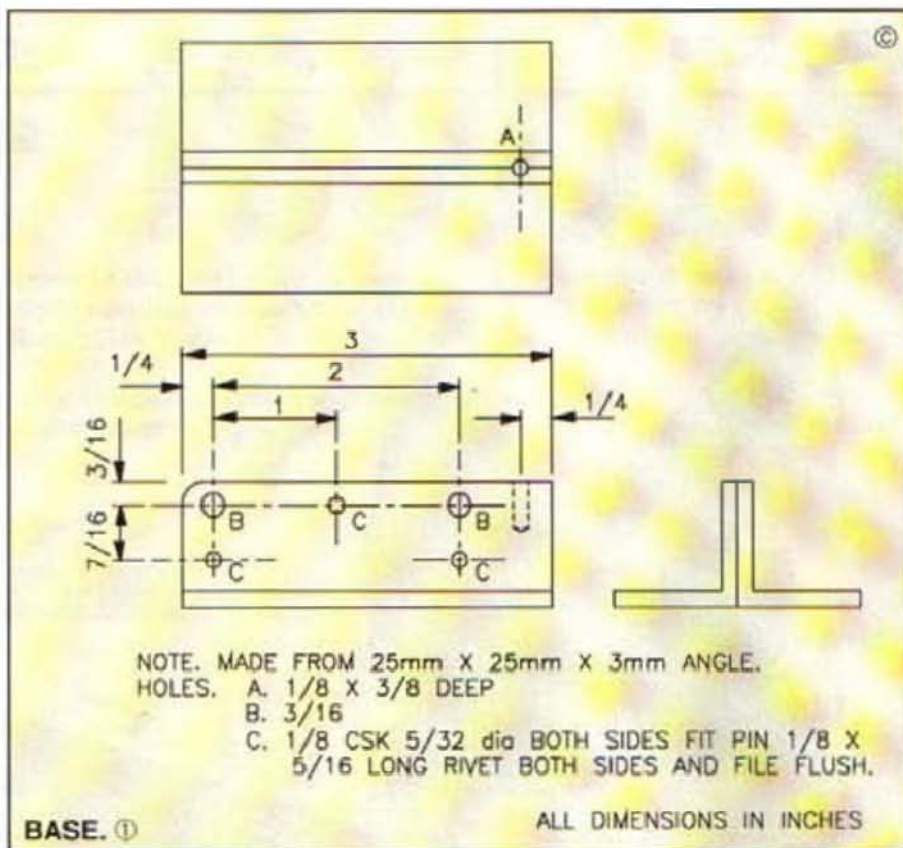
This leads to one limitation of the toggle clamp, being that, whilst it is rapid in use for batch production, this is only of real benefit if all items have almost identical dimensions. If not, the adjusting screw will have to be set for each individual component.

Even in these circumstances the toggle clamp can still be the best way to hold a component. It is of particular benefit when items are too thin to hold in a vice and therefore requires clamping down to the machine table to be worked on.

The Designs

There are numerous variations as to design and it is not intended to go into the different types in detail. The two clamp types being described (one will appear in the next issue. Ed) comprise one with a vertical pressure, and one with a horizontal pressure. The main variation that can be designed into these, is one of operator handle position.

The actual clamping can be achieved with either an upward motion, in which case the handle will rest in the vertical position, or downward with the handle finishing in a horizontal position. All other variations are too minor, and numerous, to



mention.

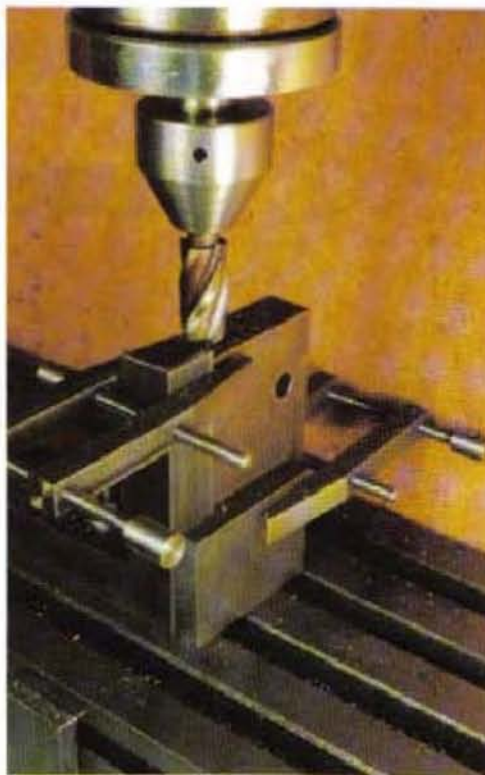
A horizontal handle position has been chosen for the vertical clamp and a vertical position for the horizontal clamps featured in these articles. Anyone wishing to make a similar clamp, but with some variation such as size, can easily arrive at a suitable design – there are no hidden mathematical ratios that must be observed.

Even so, this is, without doubt, one instance where it is essential to draw out your proposals first. Do this to ensure that the clamp will go through its required

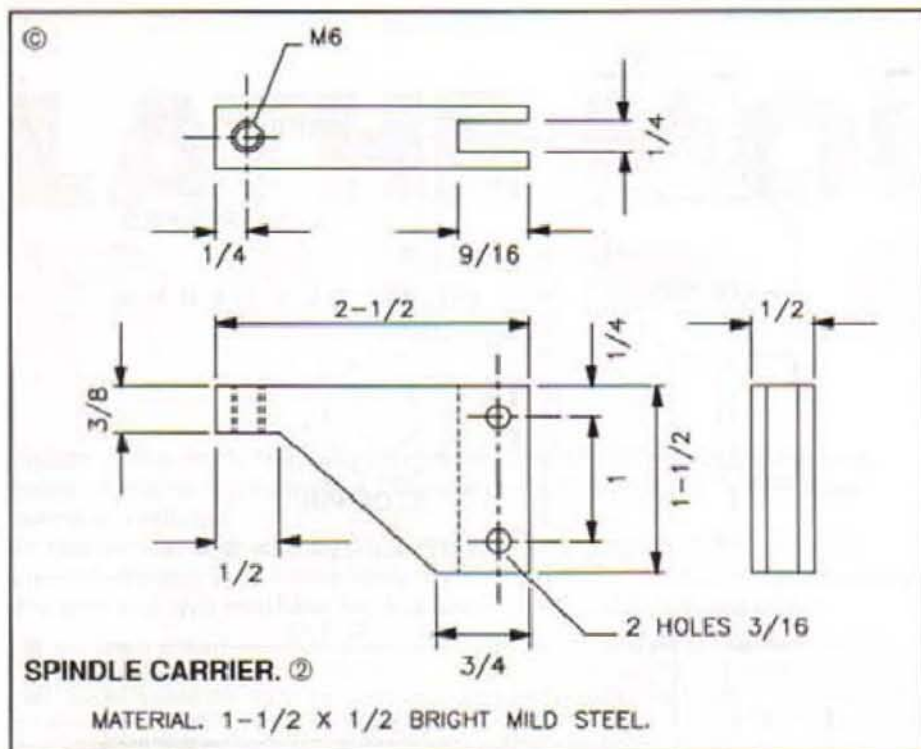
movements without fouling up at any point.

Most commercially available units will be made from formed sheet steel but this is a constructional method not normally available to the individual – at least not at the material gauges that will be necessary.

Because of this the clamps here are being made from bright mild steel and machined to shape on the milling machine. This will give a very robust clamp for its size but, as a result, is less tolerant of variations in size of the parts being held.



Above left, the method of machining the ends of the base angles; note the piece of metal clamped to the angle and being used here as an end stop to achieve consistency of length. Top right, machining the spindle carrier; the lower piece of metal is serving no purpose in this illustration. Above right, shaping the handle.



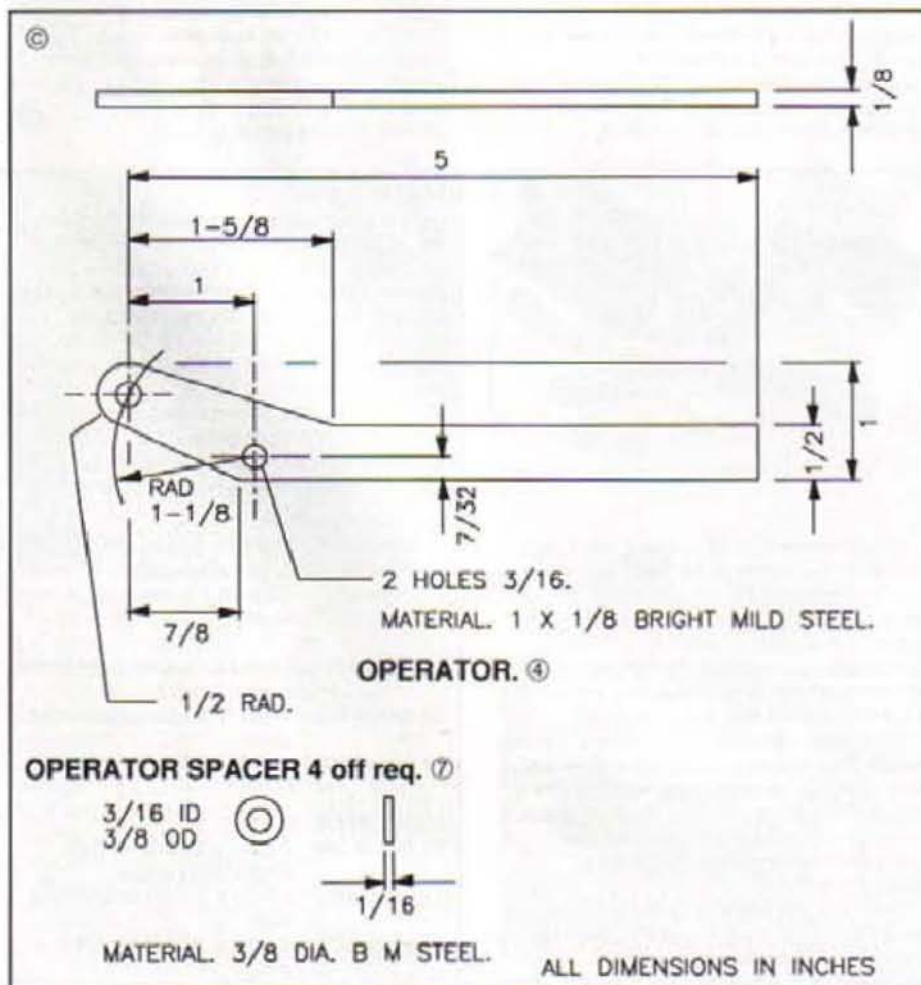
Manufacture

The manufacture of these clamps is quite straightforward, the main area to take extra care of is the hole centres which form the toggle action. Any error here may result in the clamp not functioning as intended, though this is not likely to result in total failure, only the need to adjust the shape of, maybe, the base and/or handle, to arrive at a satisfactory action.

First cut the required blanks from the various steel sizes detailed in the materials

list given at the end of the article. Here it is assumed that a pair of clamps will be made as two will be beneficial for some operations. In any case, two will take very little longer to make than one.

Start with the base, first machining the ends as shown in the photograph; the additional piece of steel, clamped to the lower part of the angle, acts as a stop. This ensures all parts are the same length without the requirement to measure each one.



Whilst the angle being used to make the base is bright and substantially square cornered, there is a small radius at the inner corner. The angle will not therefore seat adequately on the corner of the angle plate without its corner being slightly chamfered.

If you are not prepared to deface your precious angle plate in this manner, a strip of steel placed between the two parts will avoid this being a necessity. This inner radius also prevents the angles being packed together, enabling more than one base angle to be machined at the same time.

Now mark out the positions for the holes in one part and drill ALL the holes 1/8 inch diameter. Use this as a template to drill the two parts required, of the other hand, and then use one of these to drill the remaining part, the same hand as that first made. Do take extra care to ensure that the two halves line up so that the base finishes up in line.

Lightly countersink the holes that are to be used for riveting the halves together.



Closing the swivel end on the ball

Cut the rivets from 1/8 inch bright mild steel, 1/8 inch long, and rivet the two halves together. Finish by filing or machining the heads off flat.

When satisfied that the bases are adequately riveted, open up the hinge pin holes to 3/8 inch diameter, followed by the hole to be drilled between the two webs for the stop pin.

No holes have been indicated in the base flanges for fixing the clamp to the machine table as requirements for this are likely to vary. Alternatively, the flanges can be left blank and fitted using bar clamps, which is probably the easiest method.

The angle from which the clamps were made turned out not to be a true 90 degrees and, as a result, the base was not totally flat, the error being in the direction that made it hollow in the middle, not

measured but probably about 0.015 inch deep. This would flex when clamped to the machine table and should present no real problem, though it may cause the lower rivets to show sign of strain. In view of this it is probably better to machine the base flat at this stage.

Do not add the radius to the front corner until final assembly for, if done by a file, it need only be just sufficient to allow the spindle carrier to rotate. Continue by making the spindle carrier; to avoid the lengthy task of removal of metal on the milling machine, roughly shape using a hack saw with the part held in the vice. Hard work but quicker and useful exercise. The fortunate ones may use a band saw...

Now drill the two holes for the hinge pins; do this with the two parts clamped together to ensure both have the holes the same distance apart. This is not essential for the final assembly but beneficial as it enables pins to be inserted to align the parts whilst simultaneously machining the two parts as one. This procedure can be seen in the photographs.

The use of the angle plate for such machining operations can have, in some cases, a lot to commend it. Being deeper than even the largest vice likely to be available, it permits the work to be supported much closer to the machining being carried out. It is essential, though, that adequate size toolmaker's clamps are employed and these properly positioned and adjusted. Do make sure the jaws are parallel with the workpiece and, as a result, grip along their length and not just at one end or the other.

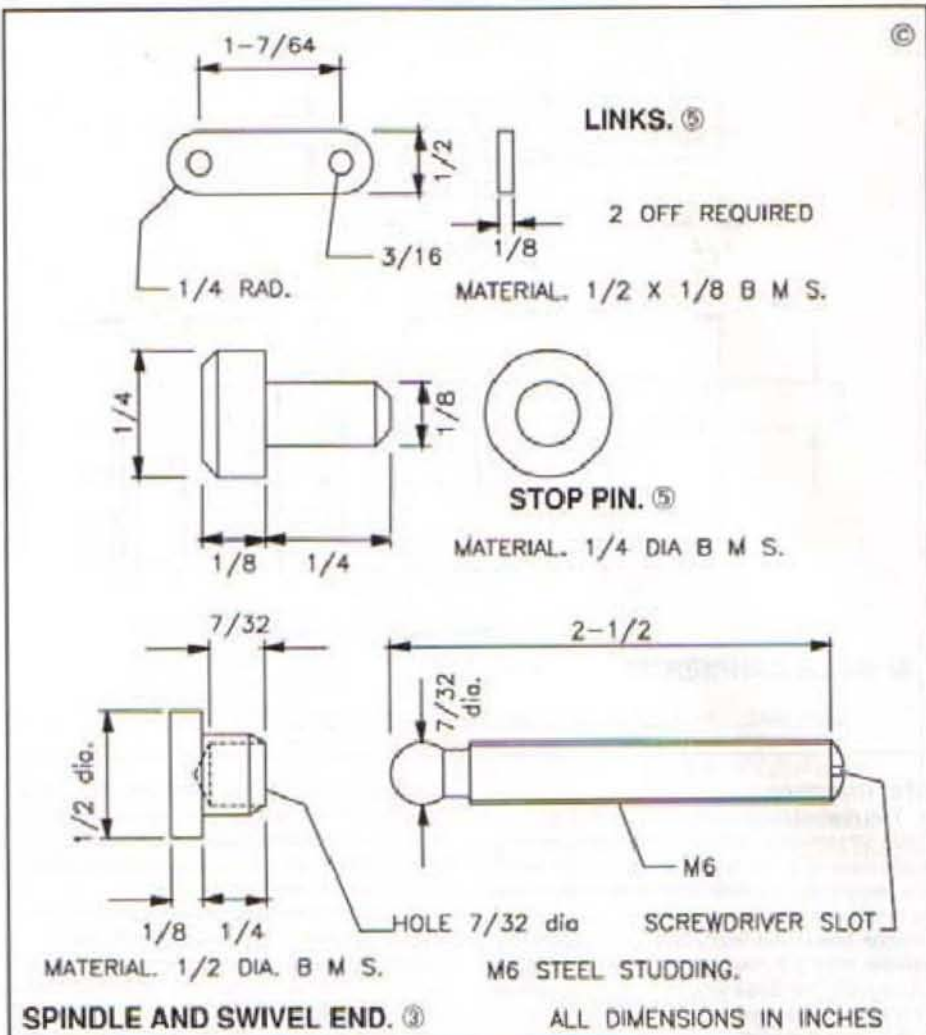
Those in the photograph are $\frac{1}{2}$ inch square cross section; even $\frac{1}{2}$ inch square would be worth obtaining, though these sizes are not readily available other than from suppliers to industry. The machining of the parts on the milling machine for the vertical clamp were entirely carried out using the angle plate though sometimes a second clamp was also used.

After shaping the spindle carrier, one can be set up for the slot to be added. Place a pin in each hole and rest these on top of the angle plate. Now firmly clamp the part to the angle plate. The pins, that have ensured that the carrier is correctly positioned for machining, can now be removed and the slot added. When the first is complete, the second can be machined similarly, followed by drilling and tapping the holes for the spindle.

Now cut two pieces of 1 inch x $\frac{1}{2}$ inch for the operator and drill the two holes. For those with a height gauge it will be preferable to calculate the hole coordinates and mark out with the height gauge. Fit pins in the two holes to keep the two parts aligned whilst shaping as per the drawing. Again, if the shape is approximately arrived at using a hack saw, the machining operation will be speeded up.

The turned parts as shown on the drawings are very straightforward. The only point worthy of mention is for the ball on the end of the spindle to take the swivel end. This is not very critical and even for those who have a radius turning attachment, it is not worth the time to set it up.

With a piece of studding carefully held in the chuck make a groove in the appropriate position, using the parting off tool. Then, using the same tool and both top and cross slides, make an approximate ball on the



end; this will be perfectly adequate for the purpose it is to serve. Providing the part is being made in a collet chuck, the ball could be tidied up using a small file. Alternatively, the drill chuck could be used but do not be tempted to use a small file close to a three or four jaw chuck.



The parts ready for assembly

There remains only to make the hinge pins and these should be from $\frac{3}{16}$ inch bright mild steel. Do ensure before making them all that, as is more normal, the material is slightly undersize. I made all mine, also for the horizontal clamps, only to find that I had one of the rare pieces of bright mild steel that was oversize!

The rivets need only be a total of $\frac{1}{8}$ inch longer than the width of the parts being held together as they require only to be very lightly riveted. Before riveting the hinge pin, assemble and test the clamp, to check that the toggle action will be satisfactory.

Only a small amount of adjustment will be achievable by adjusting the height of the stop pin included for this purpose. The provision of this facility could be left till this

stage as it may be found that the clamp functions satisfactorily without it.

When confident that all will be OK, the hinge pins can finally be riveted. A thick paper washer, fitted where appropriate and then removed after riveting, will ensure all hinges rotate freely.

Materials list

The materials list that follows details the materials for both the vertical clamp, detailed in this article, and materials for the horizontal clamp, to appear in the next issue. If some materials require to be ordered, those for the horizontal clamp can then be ordered also as some sizes are common to both.

The quantities assume two of each will be made; small quantities of round bright mild steel are required but are not listed as it is considered that these will be available.

VERTICAL CLAMP

- 15 inches off:- 25mm x 25mm x 3mm bright steel angle
- 6 inches off:- $\frac{1}{2}$ inch x $\frac{1}{2}$ inch bright mild steel
- OR
- 4 inches off:- $2\frac{1}{2}$ inch x $\frac{1}{2}$ inch bright mild steel
- 12 inches off:- 1 inch x $\frac{1}{2}$ inch bright mild steel
- 8 inches off:- $\frac{1}{2}$ inch x $\frac{1}{2}$ inch bright mild steel

HORIZONTAL CLAMP

- 15 inches off:- 25mm x 25mm x 3mm bright steel angle
- 8 inches off:- 1 inch x $\frac{1}{2}$ inch bright mild steel
- 8 inches off:- $\frac{1}{2}$ inch x $\frac{1}{2}$ inch bright mild steel

LATHE MOUNTED BAND SAW

Space in the workshop for many is at a premium, and acquiring that extra machine is not always possible even if the money to purchase same is available.

In this excellent design by Mr G Gray of Nantwich we have an ML7 mounted band saw which largely overcomes the problem. The drawings for part 1 of this machine are featured in our FREE pull-out plan.

I will begin this article by explaining that I have two workshops; the one in the garage is used mainly in the summer for woodwork. The important workshop is in a bedroom and is used for making clocks and model stationary steam engines.



In the garage I have a large three wheel bandsaw that is too big for the bedroom workshop. It was bought second-hand 20 years ago. The drive has been modified to give an extra speed low enough for cutting mild steel.

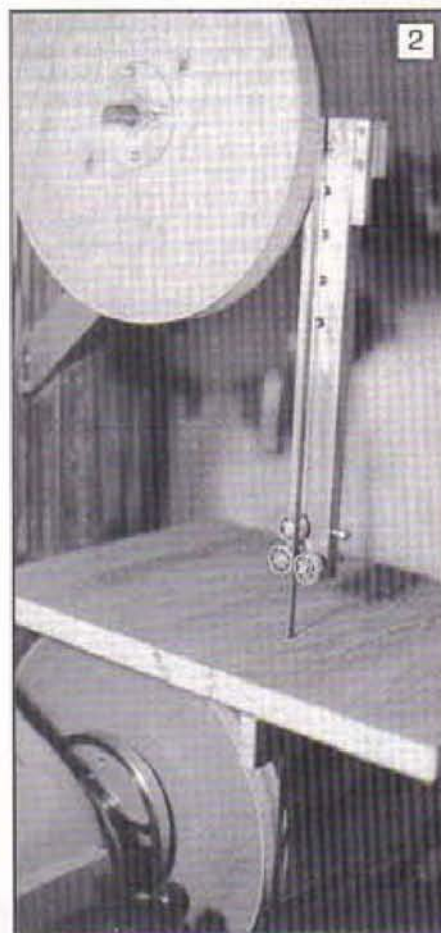
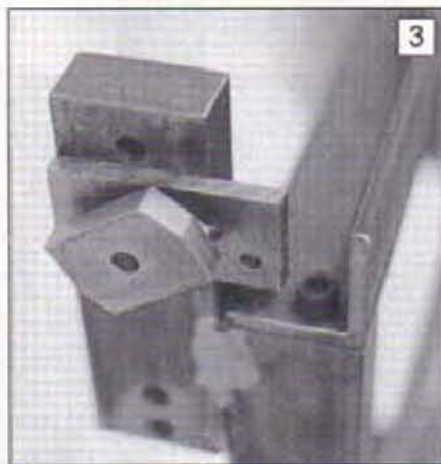
Most of my metal bandsawing requirements occur in the winter when I find an unheated garage a place to be avoided! This made me decide to buy a new small two wheel bandsaw solely for cutting metal and to use it in the indoor workshop. Unfortunately I could not find anything suitable. The only alternative was to make my own and considerable thought was given to this. I recalled that a friend of

mine has an ML8 woodworking lathe with a bandsaw attachment, so why not one for the ML7? Half the machine is already there in the motor drive and umpteen speeds at the mandrel nose.

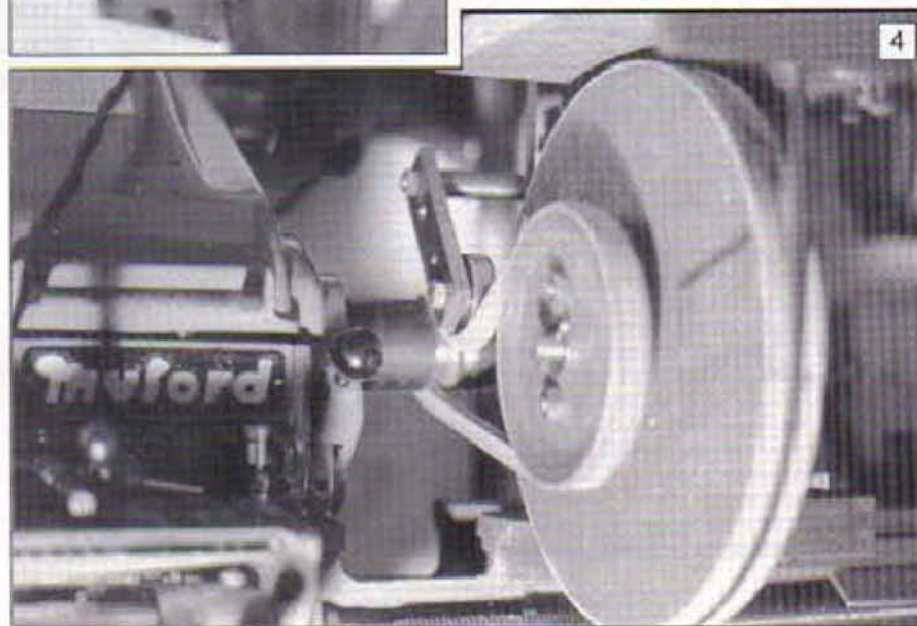
Materials and construction

A search under the garage bench revealed a piece of 2in. x 2in. x 1/4in. angle iron and 10 feet of 1 1/2in x 1/2in. B.M.S., this last item a recent bargain purchase from Whiston as likely to come in useful. I also found a used piece of 2in. x 1in. B.M.S.

The saw was originally made for direct drive from mandrel nose to bottom bandsaw wheel. (Photo No. 2). This brought the operating position too close to the lathe headstock and necessitated leaning to the left over the headstock to get



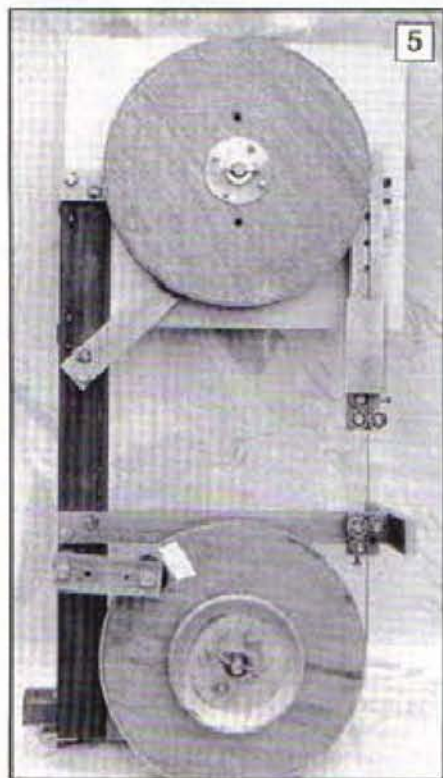
in front of the cutting position. So the foot was modified by welding on a piece of 2in. x 1in. B.M.S. to bring the centre line of the saw forward 6 1/2in. and using a vee belt drive (Photos No. 3&4).



This made a big improvement to the operating position.

For belt drive a $\frac{1}{2}$ in. vee groove was turned in the 2in. diameter nose-piece that drives the V.M.D. milling attachment. A 5in. diameter Vee pulley was fitted to the bandsaw wheel spindle driving the wheel by two pegs $\frac{1}{8}$ in. diameter at 2in. centres. The Vee belt is fitted after the saw is clamped to the lathe bed and the tension roller is dropped onto the belt and locked by tightening the $\frac{1}{2}$ BSW nut. Using the M.L.7's lowest speed without backgear a blade speed of 0.250 feet per minute was obtained.

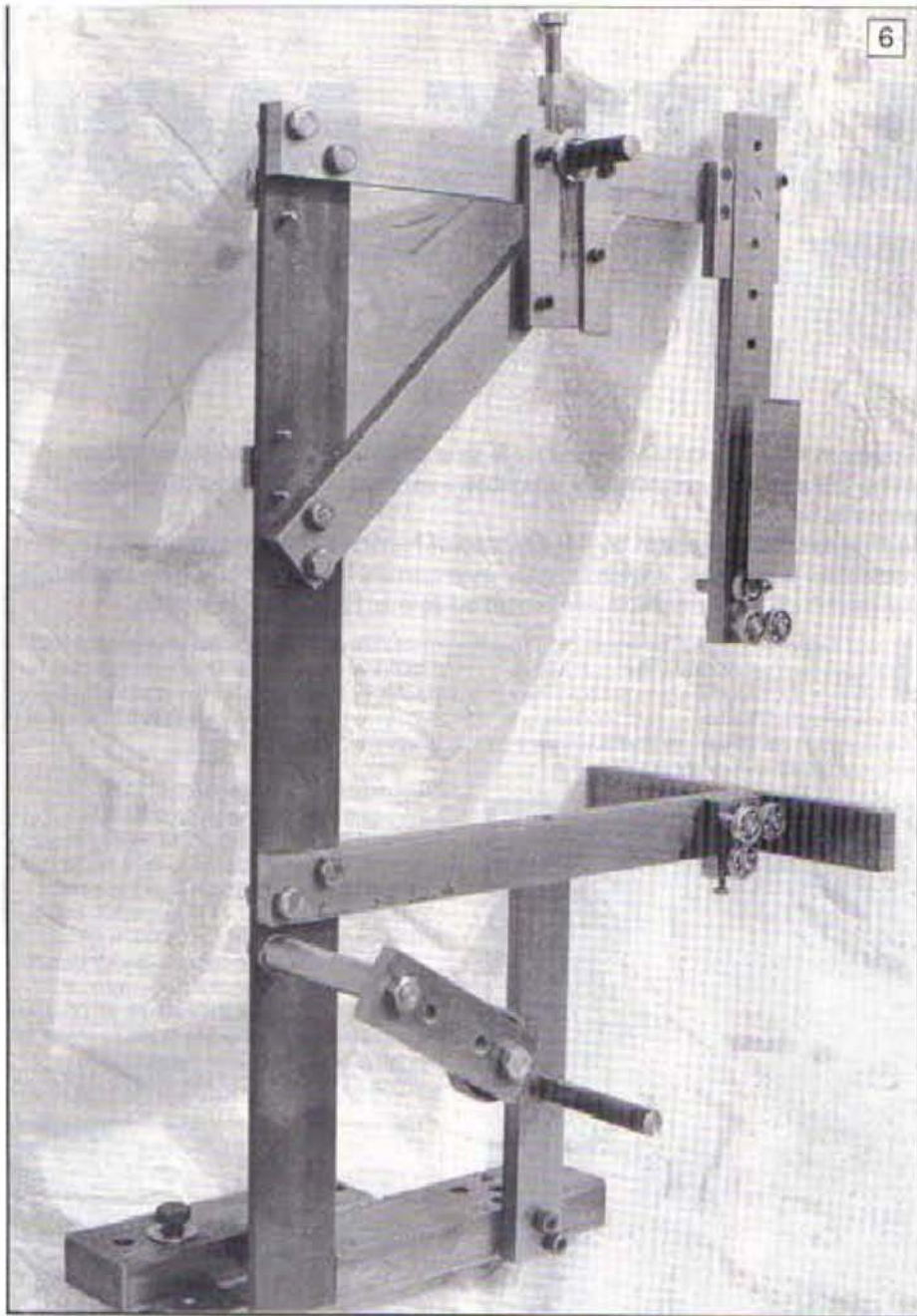
A start was made on the two wheels. Some good quality $\frac{1}{4}$ in. plywood offcuts were glued together to give $\frac{1}{2}$ in. thickness. Two discs, 10in. diameter, were bandsawn out and bolted to the lathe faceplate and, using a sharp knife tool in the toolpost, turned to 9 $\frac{1}{4}$ in. diameter and bored $\frac{1}{4}$ in. diameter. The wheel tyres were cut from 2in wide by $\frac{1}{4}$ in thick chair seat webbing and bonded to wheel rims with contact adhesive.



The wheel bushes were made from $\frac{1}{4}$ in. diameter brass bar drilled and reamed $\frac{1}{8}$ in. diameter. One end was turned down to $\frac{1}{16}$ in. diameter for a distance of $\frac{1}{4}$ in. Two discs, 2 $\frac{1}{2}$ in. diameter, were bandsawn out of $\frac{1}{4}$ in. brass plate (clockmaking offcuts) bored $\frac{1}{8}$ in. diameter and silver soldered to bushes. These bearings were secured to wheels with four 2BA bolts on a 2in. P.C.D. (Photo No.5).

The framework is simply a matter of cutting, drilling and tapping sections and bolting together. It could, of course, be welded by those with the right equipment. (Photos Nos 6 and 7). Provision must be made for tracking the blade on the wheels and this is done by tilting the top wheel. This wheel also provides blade tension.

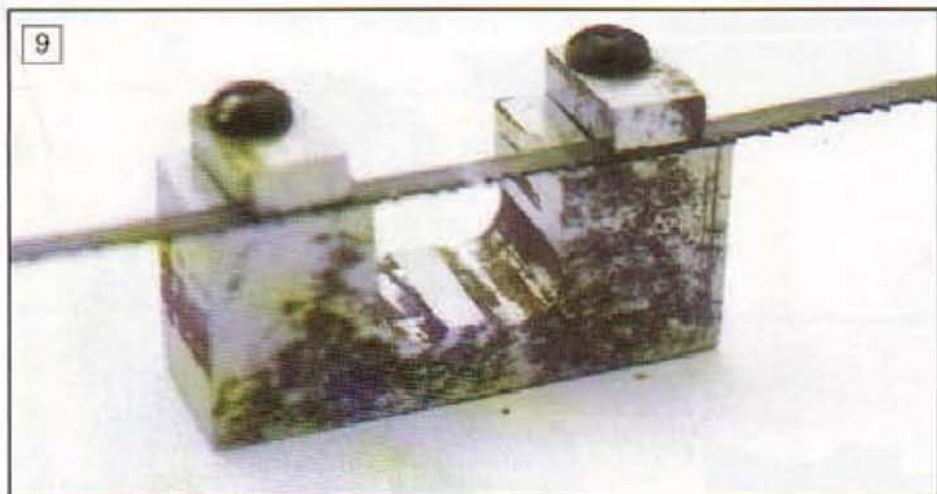
The top wheel spindle assembly slides vertically between two guides. It is raised to provide blade tension by an $\frac{1}{2}$ BSW setscrew. The tilt is achieved by fitting washers between the guides and frame at



the bottom 2BA bolts allowing the wheel spindle to be tilted by a 2BA setscrew through the frame (Photo No. 8).

The saw table is made from $\frac{1}{4}$ in. good quality chipboard faced with Formica, and fixed with M5 counter-sunk Allen screws. My table is 10ins x 15ins. but a much larger one could be fitted.





The blade

When you have completed the saw you will need a blade and it is almost certain you will have to make your own. I am at present using Starrett $\frac{1}{16}$ in x 0.025in. x 14 T.P.I. Raker. Cut a length plus $\frac{1}{16}$ in. in this case $67\frac{1}{2}$ plus $\frac{1}{16}$ in. Scarfe each end back a $\frac{1}{16}$ in. on the grinder and clean up with a 6in. three square file. Put the jig in the vice and clamp the ends of the blade in the jig with the scarfed ends barely touching. (Photo No.9) Easy-flo the joint and clean up both sides with same file maintaining 0.025in. thickness. If, despite all your efforts, the teeth are pointing the wrong way, simply turn the blade inside out!

The six ballraces used to guide the blade should be fully shielded. The ballrace shafts are $\frac{1}{16}$ in. diameter with the ends turned down to $\frac{1}{32}$ in. diameter, the four side pressure shafts turned eccentric and the other ends provided with two spanner flats. The ballraces are fixed with Loctite 641.

Setting up

To set up the saw, fit your new blade on the centre of the wheels and tension until there is $\frac{1}{16}$ in. side play on the straight. Run the lathe at its lowest speed and adjust tracking screw until the blade runs about on the centre of the bottom wheel rim.



Stop the saw and adjust the top set of ballraces up to the blade. Now mark off, drill and bolt on bottom set of ballraces and adjust. Fit the table and check it is square with the blade. If not fit suitable packing under the table.

Commercial bandsaws are fitted with a tilting table but having so rarely used this facility I decided not to bother with it. I find a light close to the work area is essential and I fitted a 40Watt small bayonet candle lamp with a brass reflector.

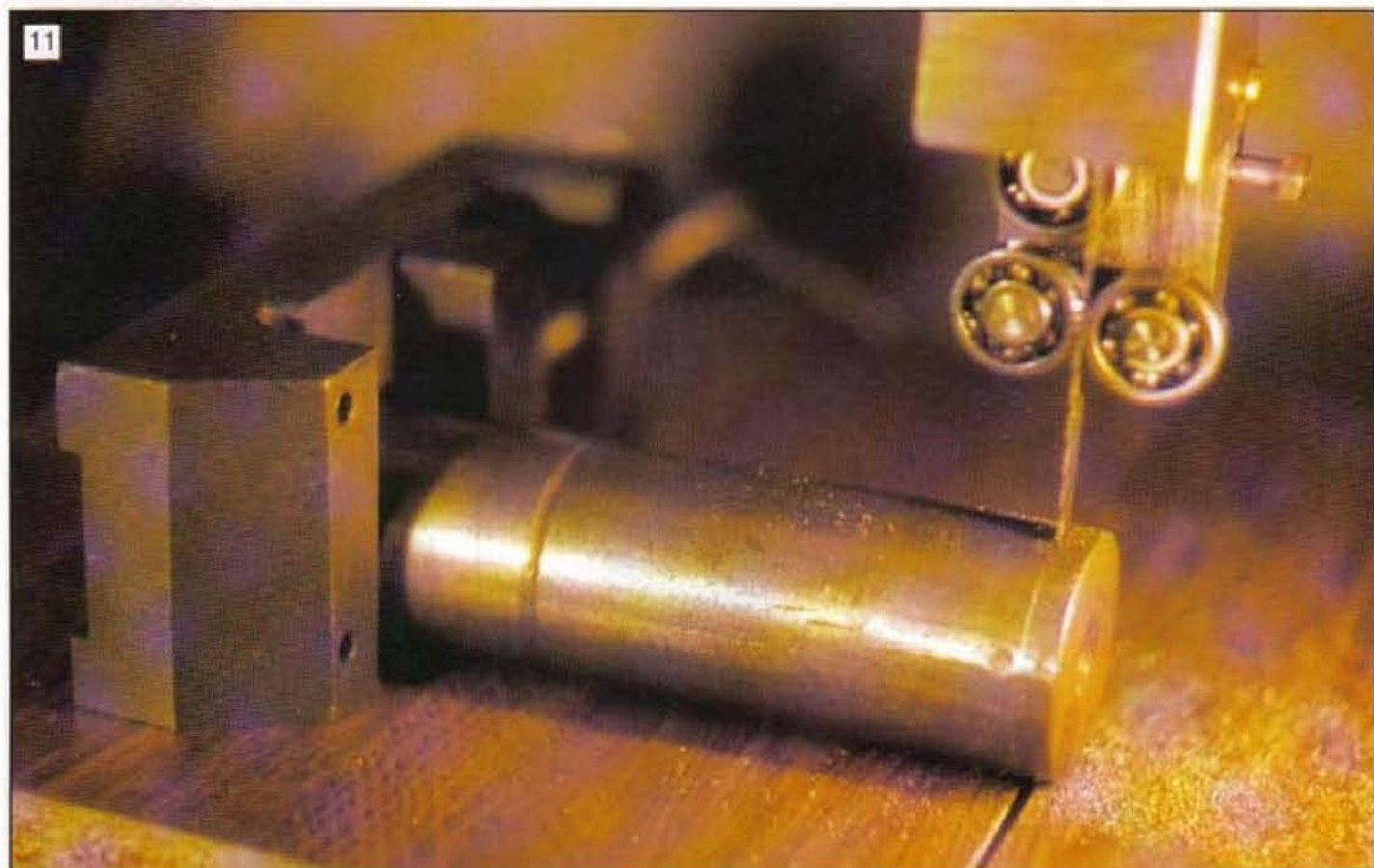
Photo No. 10 is a close up of a cut in 2in. x 1in. B.M.S. and it shows it is possible to split the scribed line. **Photo No. 11** shows cutting $1\frac{1}{2}$ in. diameter mild steel and use of a machine vice to stop it rolling.

We now come to an essential but boring part of the job and that is the guards. When

QUICK TIP

As the user of two small lathes, a Unimat 3 and a Compact 5, one of the most useful purchases I ever made was a set of stub drills. They were a job lot purchased at the Model Engineer Exhibition and were a virtually full set of number sizes from 1-60, that is about 1 to 6mm in metric speak. The particular advantage they have on a small lathe is that they don't need as much end on working space as a standard length drill, space which, on the relatively short beds these lathes have, is at a premium. Stub drills are also stiffer and stronger than jobbers length drills. Stub drills are not standard items in shops (and probably expensive list price) but if you see some, buy!

J. Jennings



I sent the editor some photos and asked if he would be interested in an article he said "Yes, but where are the guards?"

They are again made from plywood offcuts, this time $\frac{1}{4}$ in. and $\frac{1}{2}$ in thick simply glued and panel pinned together. I use Bostik Rapid Bond wood glue which allows the joint to be handled in about 15 minutes. It is only possible to make the guards in two parts. The bottom guard which covers the wheel and Vee belt drive is in the form of a box which simply slides on. It also collects the swarf, the containment of which is essential in an indoor workshop (Photo No.12).

The top guard covering the top wheel



and rising blade on the left is hinged on the left and opens right to left (Photo No.13). The hinges are modified to allow the guard to be lifted off. The rear of this guard is fixed by two 2BA nuts on two of the 2BA bolts in the top rail of the saw assembly. (Photo No.14) The downward moving blade in the working area has a sheet steel guard fixed to the blade guide carrier by two 4BA screws (Photo No.15).

I think I have covered everything now. I did not have to purchase a single item to make this bandsaw, everything came from under the bench or out of the O & S boxes! I hope you are as lucky.

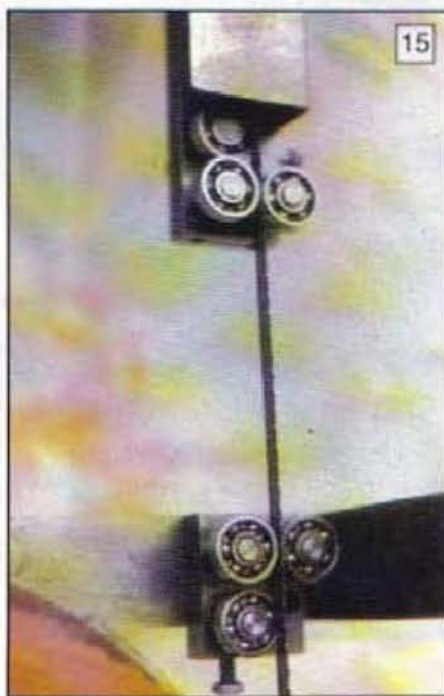
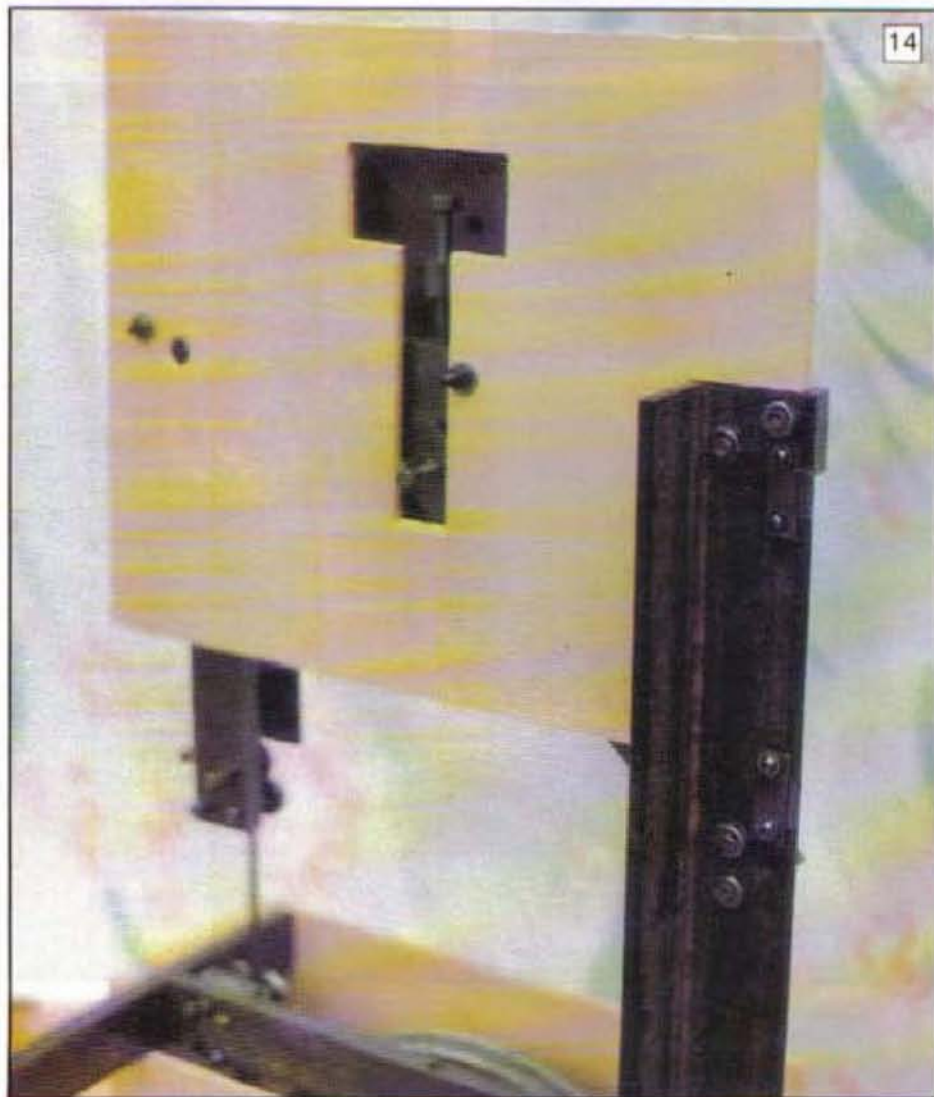
Postscript

This article proposes a non-standard band saw length of 67.5 inches by 0.25 inches wide. Standard band saws are available 70.25 inches long by 0.25 inches wide. This additional length of 2.75 inches could be accommodated by increasing the height of the rear angle from 22 inches to 23 $\frac{1}{4}$ inches and the upper blade support arm from 10 $\frac{1}{4}$ inches from 12 $\frac{1}{4}$ inches. The upper covers would also require increasing in height similarly.

Typical supplier, Graham Engineers, Alpine House, Roebuck Lane, West Bromwich, Birmingham, B70 6QP. Tel: 021 525 3133. Alternatively special blades can be purchased from: Bandsaw Service, Fairacres Industrial Estate, Dedworth Road, Windsor, Berks. SL4 4LE. Tel: 0753 862029.

The constructional drawings for this item will be covered in the centre fold of both this and the next issue of Model Engineers' Workshop. This is to enable sufficient detail to be included.

The centre fold of the next issue will include additional assembly information, manufacturing details for the more important parts and drawings for the shrouds. - Ed



A VISIT TO INTER CITY MACHINE TOOLS

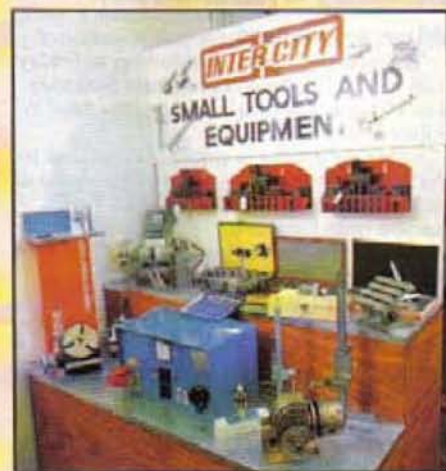
A recent visit to Inter City Machine Tools at High Wycombe enabled me to renew acquaintances with a firm I had visited some 20 years earlier, then in search of a small second hand surface grinder for use in a new small machine shop I was helping to set up at the firm I worked for.

Inter City Machine Tools was set up some 25 years ago to trade predominantly in second-hand machines, as it does today, though there are many new machines to be seen also, many of which are suitable for the small workshop.

Aladdin's cave

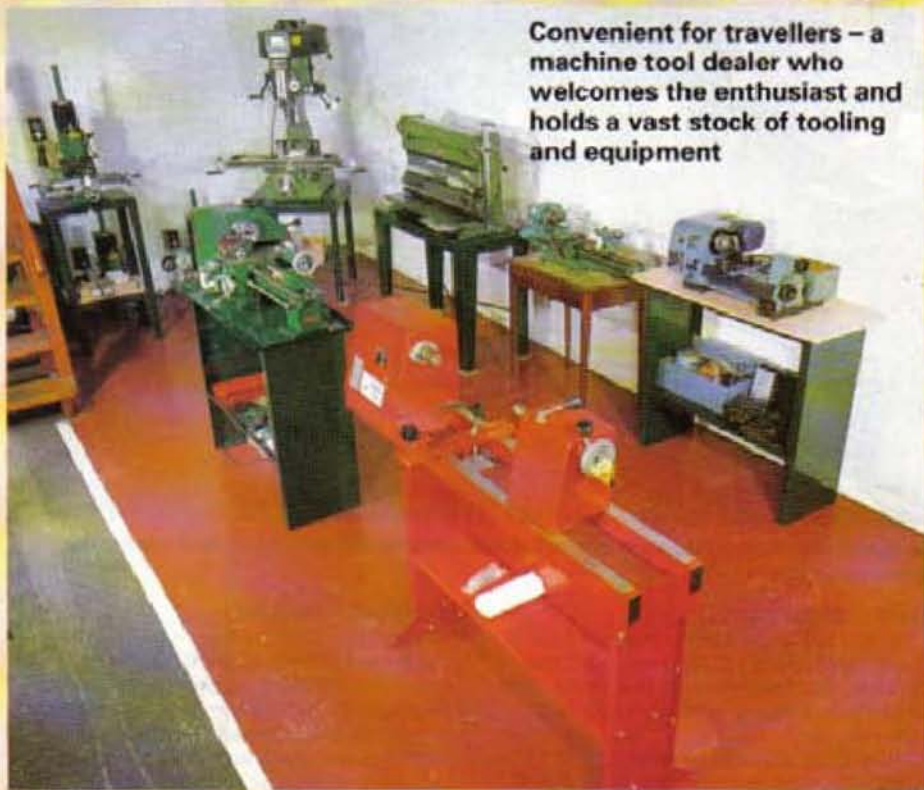
The visit revealed an Aladdin's cave (I think that should be an Aladdin's cavern) of machines and accessories of every shape, size and type!

It is certain that very few readers will ever have seen so many machines at one time. Of course, the majority are of a size quite inappropriate for the home workshop. With so many machines this still leaves many of a suitable size, say 3½ inch lathe and complementary machines of other types.



Above: A display of just a few of Inter City's new small tools and equipment.

Below: Some of the secondhand stock of small to medium lathes; a Myford Series Seven can be seen in the right foreground.



This photograph shows Inter City's range of new machines aimed primarily at the home machinist. From left to right against wall, a small drill mill of unusual design, a large drill mill, a sheet metal machine, a Myford lathe, a small centre lathe of Russian origin. In front, left, Inter City's own CT 918 centre lathe, and right a woodturning lathe. No Inter City are not going into the replica market, the Myford lathe is a second hand ML2/4 (?) in exceptional condition.

The quantity of accessories is staggering, as is the range. These cover all the usual and not so usual items. Micrometers by the drawerful for each size – except, that is, 0-1 inch which are in short supply. Shelves full of items, including angle plates, rotary tables, surface plates. Again many of these are of a size which are

too large, but there are still many suitable for all but the smallest workshop.

The numbers

Let's put some numerical values to these statements, and thereby make the position clearer. There are in excess of six hundred machines and five thousand accessories (given in words, just in case you may have thought an extra nought had been typed in, in error!).

These quantities are known accurately as each item is recorded on computer, and print-outs from these lists are available on request, but more about that later. Besides these items listed, there are countless small (?) tools such as drills and reamers, etc. This quantity makes Inter City the largest operation of its kind, in the south of the United Kingdom.

You may consider with so many machines, many of a large size, that the operation is aimed at industry and, as a result, that the home machinist was not that welcome; nothing could be further from the truth.

Individuals are welcome to arrive and browse around whenever they wish. No one will complain if you spend time drooling over the fifteen foot lathe, even though you know you will not be purchasing it ...



Just one of a range of displays of small machines, this one bench and floor mounting drilling machines.

New machines

Whilst the emphasis is on second-hand tools, there are still many new machines to be seen, nowhere more so than in the sizes of machine that we are likely to be interested in.

Inter City's attempt to cater for the model engineer is evident by the range of new machines of a suitable size available. This includes a fully equipped lathe 4½ inch centre height x 18 inches between centres. A mini drill/mill with a table size 3½ inch x 15 inch, and equipped with an electronic variable speed drive, this machine, of a type that I think is new to this country.

Besides those there is a larger mill/drill, a universal sheet metal working machine, wood lathe and others. Many new industrial size machines are purchased also by Inter City. This volume of business gives them some ability to dictate to the manufacturers their own requirements for improvements to the smaller machines. These bring the machines up to the standard expected by the UK market, and help them to compare very favourably with other suppliers of similar machines.

New small tools

They also have a good range of new small tools, too many to mention. Two items that did look particularly good value were, first, a set of telescopic bore gauges covering ½ to 6 inches and costing £45.00 + VAT. Another item was a series of slotted and precision ground angle plates, typically 6 x 5 x 4½ inch costing £23.00 + VAT.

Returning to the second-hand range there are many small machines. These include fly presses, arbor presses, pedestal and bench drills, lathes and vertical milling machines, though for the latter item there is likely to be less choice.

For the enthusiast with space and money available, there are such items as small engraving machines, cutter grinders, surface grinders, horizontal milling machines, etc.

Getting it on site

One very good facility, not always available from many other suppliers, is that Inter City will deliver major items on their own transport. This comes complete with large extension unloading crane, and within reason (say, not upstairs) they will manoeuvre the machine into its final position.

This will be particularly beneficial if you purchase a large item, say a Harrison L5 or a Colchester Student. When purchasing you will of course need to discuss the situation with them.



One of a range of good quality new angle plates supplied.

Machines reconditioned

Almost all the larger size machines will be stripped down to the last nut and bolt by Inter City's machine tool fitters, then reconditioned and repainted. Except for the grinding of the larger slideways, all required machining is done in their works.

A few, though not all, smaller machines are left as obtained. This gives the private

individual the chance to purchase a machine at the lowest possible price, and then recondition it himself.

Three-phase converters

One problem with many ex-industrial machines, is that they will be fitted with three-phase electrics. Often it will be no problem replacing the motor with a single phase unit but where the size of motor or method of mounting prevent this, Inter City are able to supply a three-phase converter from a reputable source.

A full printed catalogue is produced twice a year; this easily gets out of date regarding second-hand items, two computer-generated lists are always available. These are one for machines and one for accessories, and can be requested at any time.



A set of new Telescopic Bore Gauges available at a very reasonable price.

When and where

The opening times are Monday to Friday 9.30 to 5.30 (no lunch break) and Saturday 9 to 12 noon; parking is reasonably easy in adjacent roads.

Inter City is easy to get to, being close to the M40 Junction 4. The route from there is as follows: Leave the M40 at Junction 4 leading onto junction roundabout. Pass across front of Forte Hotel and take left turn immediately alongside the hotel, sign-posted A4010 Aylesbury.

Proceed ahead to 3rd roundabout (first a mini roundabout). Go straight ahead for approximately 400 yards taking 2nd turning on the right (Rutland Avenue).

Proceed for 100 yards, taking first turning on the right (Chairborough Road). Follow Chairborough Road down hill to tee-junction and turn right. Proceed 20 yards to first turning on left which is Lindsay Avenue. Inter City building is located on right hand side.

Alternatively, if you approach from the town centre, leave the centre on the A40 in the direction of Oxford/Aylesbury. After about 600 yards turn left into a side road and stop and ask - you will be very close to Inter City.

Inter City Machine Tools (High Wycombe) Ltd., Lindsay Ave., High Wycombe, Bucks, HP12 3ER, telephone number 0494 533211. They take credit cards and will accept 'phoned orders by this method. Used machine tools are purchased with a thirty day money back warranty.

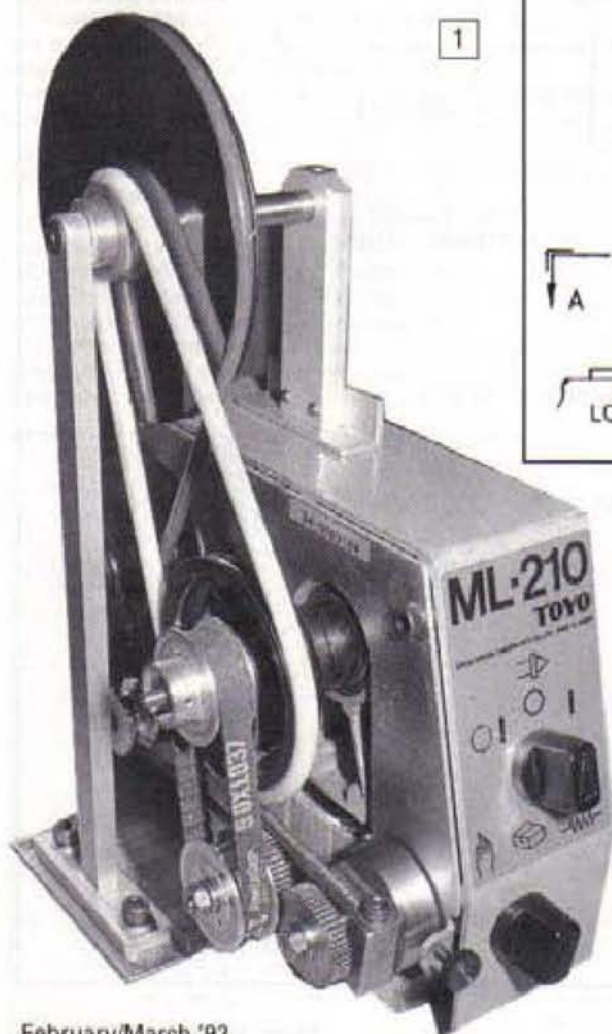
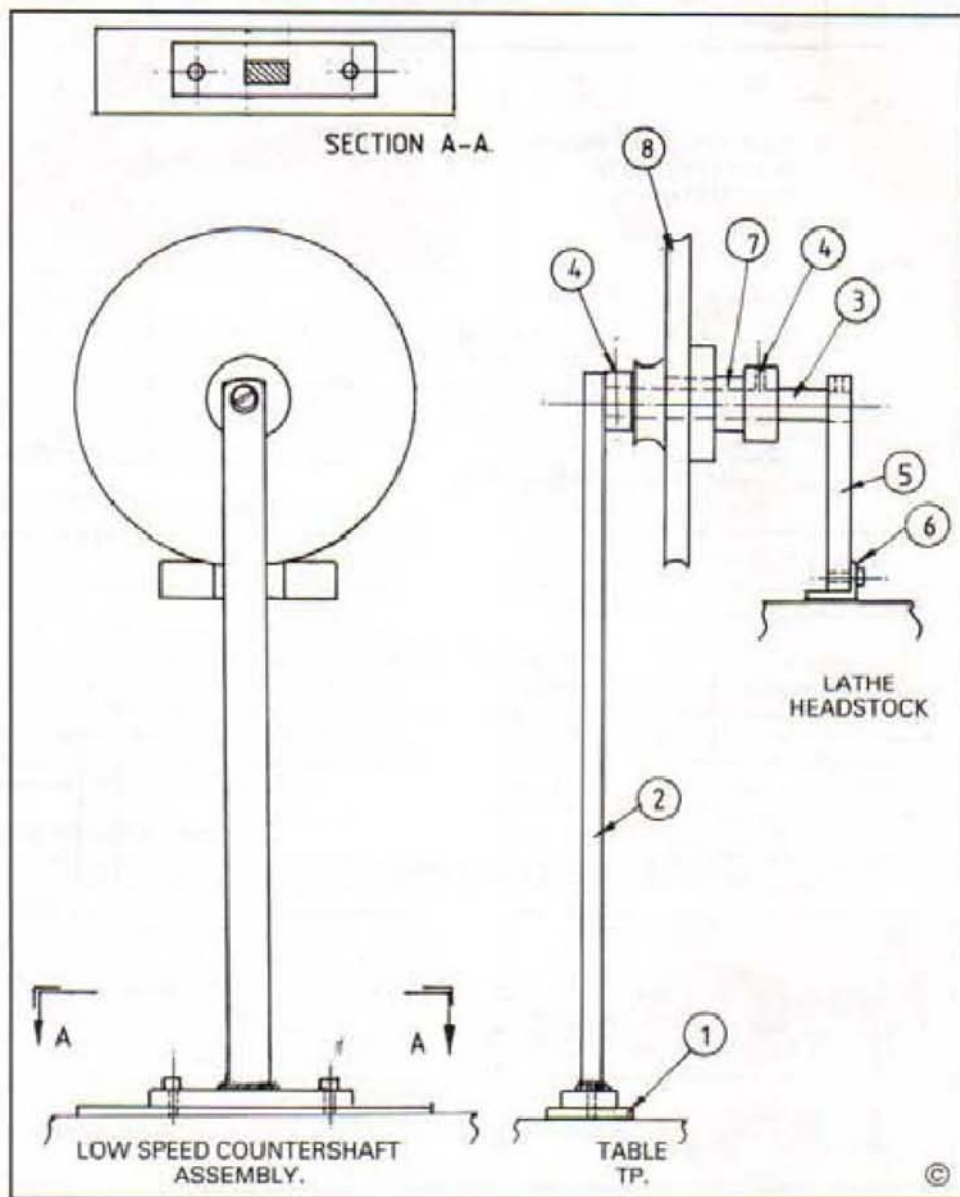
Finally, a warning. Do not take the family unless they are very patient - I cannot see you getting out in under an hour, and most probably much more!

A LOW SPEED COUNTERSHAFT

D.P. Winks has described a series of modifications he has made to his Toyo ML210 lathe in order to get better results. This time he tells of a countershaft to reduce the speed and other small accessories for the lathe

The lowest speed provided by the standard cone pulley on the Toyo 210 is 280 rpm which is too fast for some jobs, especially screwcutting. The makers provide a device using worm gears, which is quite expensive, and requires some dismantling to fit. The simple countershaft shown in **Photo 1** does the job adequately, and can be fitted and removed very quickly. It gives a speed of approx. 100 rpm using the smaller step of the motor pulley.

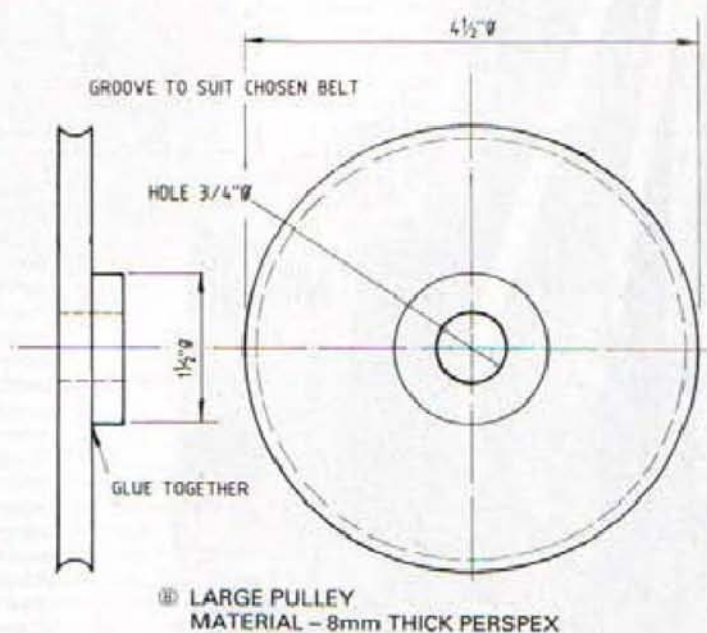
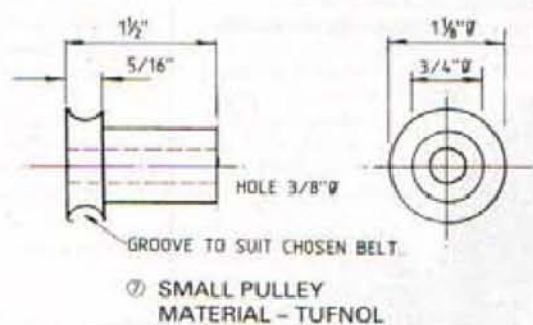
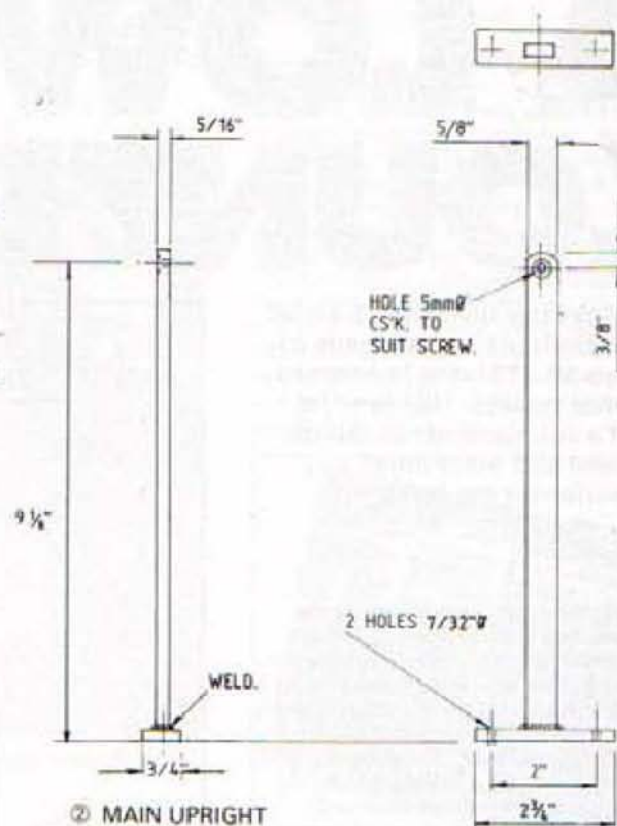
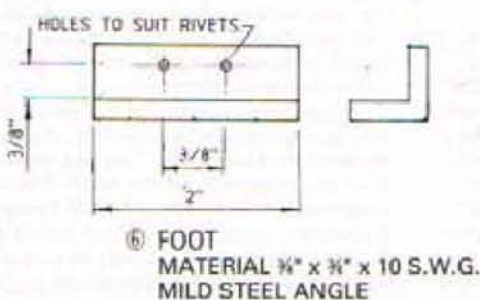
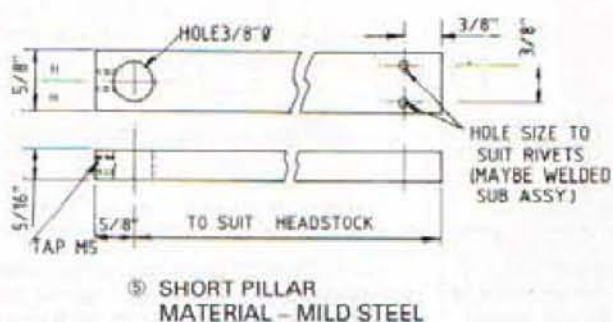
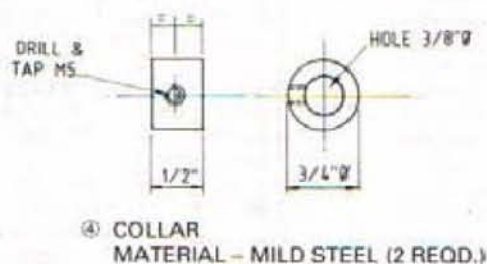
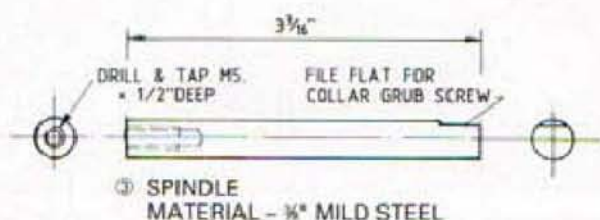
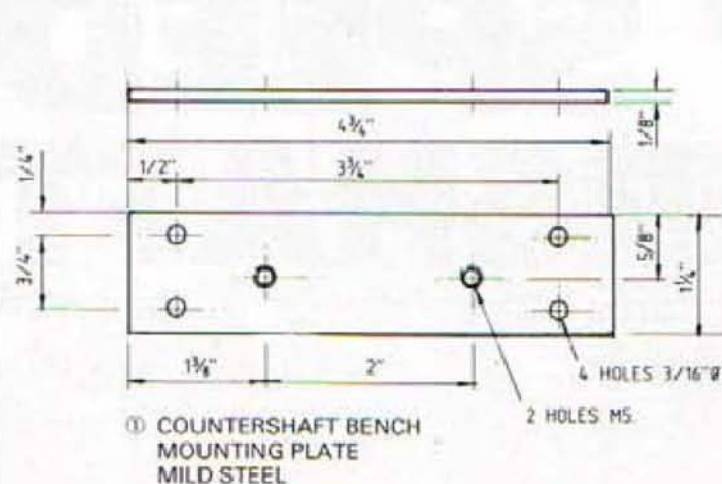
A vertical column of $\frac{1}{2}$ in. x $\frac{3}{4}$ in. flat steel 9.5 in. high carries a shaft of $\frac{1}{2}$ in. ground steel rod at its upper end. The other

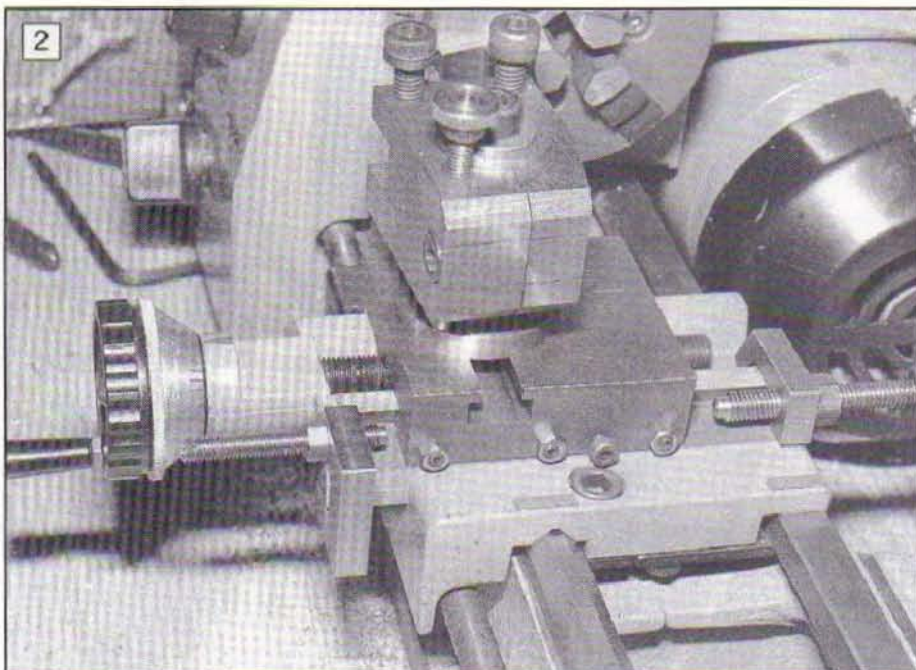


This view of the countershaft fitted and ready for use shows how it is possible to quickly position it on the odd occasion when a low speed is called for. The shaft and drive belt can be quickly removed and stored when the lathe is required for more normal duties. Main agents for the Toyo range of machine tools are Messrs. Millhill Tools, 66 The Street, Crowmarsh Gifford, Oxon., OX10 8ES.

end of the shaft (which does not rotate) is supported by a foot which rests on the top of the headstock, as shown. No fixing to the headstock is needed as the belt tension keeps the device in place. The lower end of the column has a foot which can be fixed with two Allen screws to a tapped steel footplate which is left-fixed to the bench top with woodscrews.

The small pulley on the countershaft was turned in one piece with the bearing from 1.1 in. Tufnol rod. This was reamed $\frac{1}{8}$ in. to run directly on the shaft. The large pulley was cut from 8 mm black Perspex, 4.5 dia. and cemented to the small one with Araldite. Two spacing collars to locate the pulleys on the shaft complete the job. The small pulley lines up with the largest step on the mandrel cone, the large one with the centre step of the intermediate cone.





The plastic belting from Shesto, 5 mm dia. was satisfactory for the faster drive, but was too stretchy for the final one; it would not transmit the torque required. Roundthane belt, 1/4 in. dia. obtainable from G.L.R. Distributors, was much better for this purpose, as it is made from a harder type of plastic. It is hollow in section, and is joined by pressing in a special metal fastener.

The set-up could be criticised on the grounds that the belts are unguarded; however I think it is acceptable for use in a private workshop. For educational purposes, it would not be difficult to attach a sheet-metal or wire mesh guard.

Odds and ends

Except for the screw cutting attachments (*in next issue*, Ed) this now completes the main additions to the Toyo lathe which I have made so far. The following are a few smaller items which have proved useful.

Cross-slide stops

It is an advantage to have an adjustable positive stop to the cross-slide movement, especially for repetition turning and for screwcutting. Those shown in **Photo 1** are easily made; the construction is clear from the photograph. The clamps are made of 1/4 in. thick brass slotted to fit over appropriate parts of the saddle casting. They are secured with 3 mm Allen grub

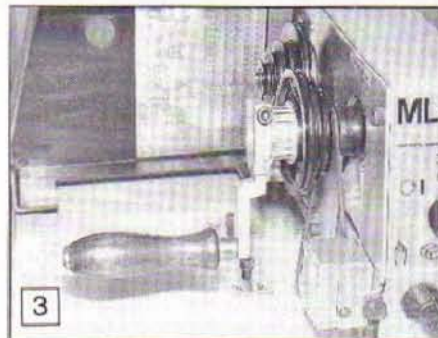
screws, the points of which bear on unmachined surfaces of the saddle so there is no damage. The stops are lengths of M5 studding, with lock nuts. They do of course restrict the cross-slide travel available but this has not been a problem for the type of job for which they would be used.

Micrometer feed dial (Photo 2)

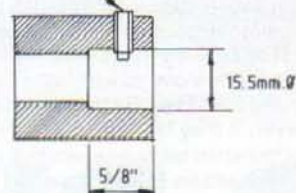
The index dials supplied with the lathe are very difficult to read as the graduations are moulded in the black plastic; as the lines are raised, not incised, it is not possible to fill them to improve legibility. I made a replica (**Photo 2**) in aluminium and graduated it in the usual way with incised lines filled with black paint; this is much easier on the eyes. There are 40 small divisions, each being equal to 0.025 mm which is near to 0.001 in.

Mandrel handles

For some purposes (e.g. threading with dies) it is necessary to turn the mandrel by hand. The first handwheel I made was a standard Picador wheel bored out to fit on the tail of the mandrel, which has a flat on it so that a grub screw can be used without damage. This was satisfactory for threading with dies held in the tailstock, however it cannot be used with the screwcutting gears as the mandrel tail is occupied. I made a new handle bored 3/4 in. to fit on the boss of the 18-tooth pulley.



1/4" B.S.F. ALLEN GRUB SCREW WITH BRONZE PAD IN INNER END.



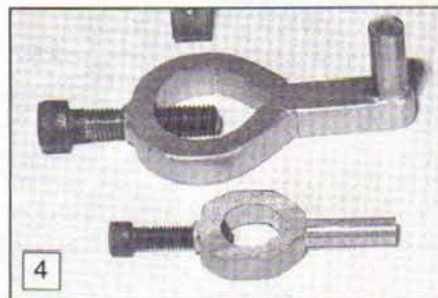
MANDREL HANDLE

THIS COMPONENT IS A "PICADOR" 4" ALUM. HANDWHEEL WITH THE BOSS MODIFIED AS PER SECTION. (ORIGINAL BORE = 1/2" Ø)

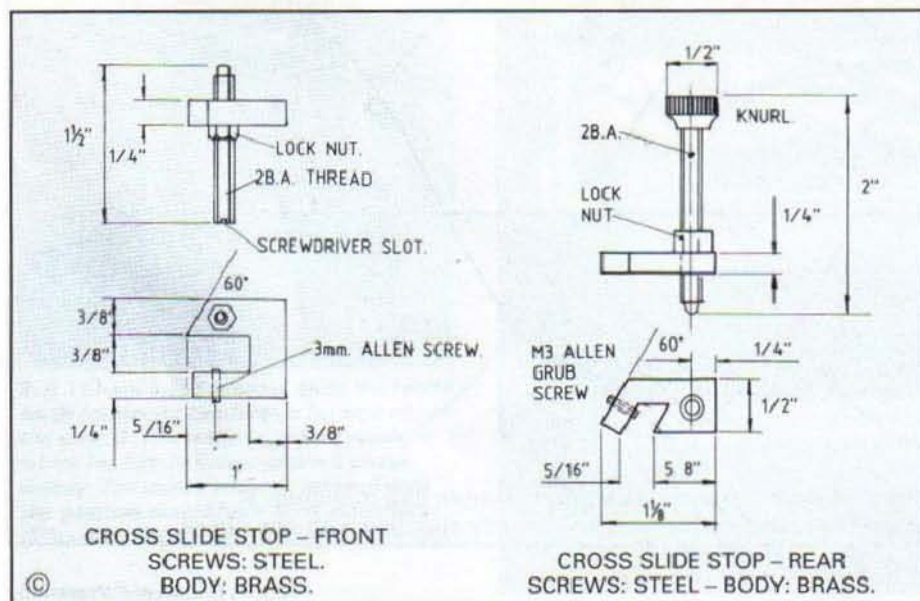
This is shown in **Photo 3**. It is useful for screwcutting up to a shoulder, where even the slowest powered speed is too fast.

Carriers

Two carriers were made, a larger one of steel 3/4 in. thick with a capacity of 5/8 in. which is of conventional form with a bent tail to fit into a faceplate slot. The smaller one is of brass 3/8 in. thick with a straight tail short enough to swing over the cross-slide; its capacity is 3/8 in. This requires a driver pin to be fitted into the faceplate. These can be seen in **Photo 4**.



This completes the work done on the lathe so far, which has greatly enhanced its utility at comparatively low cost, although it must be admitted has consumed a good deal of time. The next job will probably be a knurling tool which will of course be of the two-wheel 'straddle' type to avoid heavy loads on the mandrel bearings. Also, a lever feed tailstock as previously mentioned would be useful.



CROSS SLIDE STOP - FRONT
SCREWS: STEEL.
BODY: BRASS.

CROSS SLIDE STOP - REAR
SCREWS: STEEL - BODY: BRASS.

List of suppliers

Note - The author has no connection with any firm mentioned here.
G.L.R. Distributors Ltd., Hartham Lane, Hertford, Herts, SG14 1QN.
Metals, Tufnol, Belting.
Shesto, Unit 2, Sapcote Ind. Estate, 374 High Rd., Willesden, London NW10 2DH.
Plastic belting.

In the second article on the electricity supply to the home workshop, we will look at the advantages of a three phase supply, and the practical aspects of introducing it to the home workshop.

What is three phase?

In this country, electricity is generated and transmitted using three phase alternating current. In simple terms, alternating current means that the voltage fluctuates from minimum to maximum 50 times a second (hence the term 50 cycles) and each of the three phases are timed so that the voltage reaches the minimum or maximum at regular phased intervals. (See **Figure 1**). The actual voltage varies because it is cheaper to transmit electricity at very high voltages, but for safety reasons this is transformed to lower voltages for distribution in urban areas.

All three phases are retained right up to the service cables in the road outside private houses and directly into industrial premises (see **Fig. 2**). In rural areas, however, it may be more economic to only



Close up of the converter itself showing how compact a unit can be.

3 PHASE IN THE V

run a single phase to a row of isolated cottages or a farm. The voltage between phases is 415 volts and all equipment designed to run on three phases will be rated at this voltage. My previous article (*M.E.W.* Dec '91/Jan '92) dealt with the safety aspects of mains electricity and whilst it is true that 415 volts will give a more severe electric shock than a 240 volt supply, there should never be any question of 'shocks' if the safety rules are followed and therefore a three phase supply is no more dangerous than the normal domestic supply.

Why three phase?

Many readers may well be asking at this stage, why on earth should I even consider a three phase supply for the workshop?

Following up the article by Mr Boucher in the last issue regarding electricity in the workshop, he now continues with some practical advice on overcoming the problems of using three phase motors, as frequently fitted to surplus industrial machines

There are, in fact, many reasons. One of the most likely is the chance to acquire redundant industrial plant at knockdown prices. Many old lathes, drills and mills are thrown on the scrap heap when a factory reorganises or modernises, and almost invariably they will be fitted with three phase motors.

Model engineers can afford to spend the time to overhaul such machines so that they can equip a workshop at a fraction of the cost of new machine tools. It is of course possible to fit single phase motors and controls in a number of cases, but

large single phase motors are expensive and have complicated capacitor start circuits. Smaller ex-washing machine motors can be picked up cheaply from the local scrapyard, but these tend to underpower industrial machine tools. In the author's case a small milling machine became redundant at work and was immediately purchased. Examination showed that the three phase motor was integral with the gear box and was designed to run at two speeds. Replacement with a single phase motor would have been difficult and would

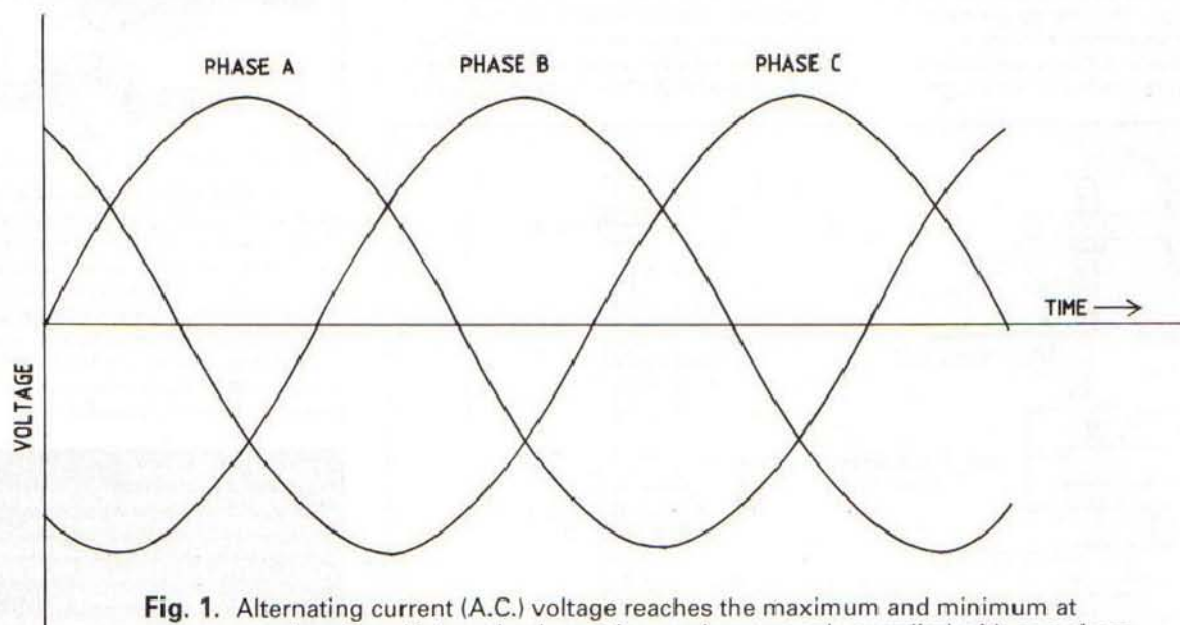
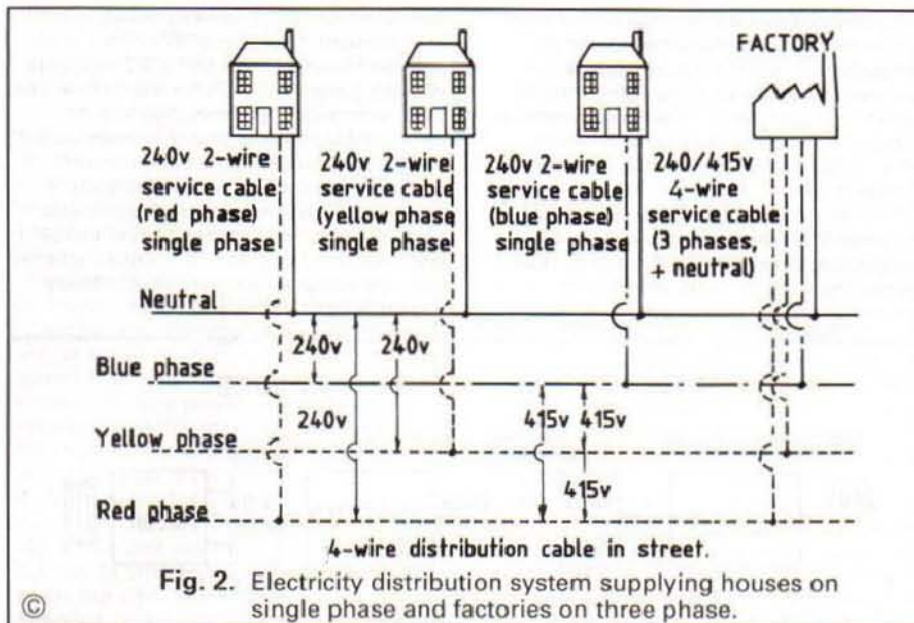


Fig. 1. Alternating current (A.C.) voltage reaches the maximum and minimum at regular phased intervals; domestic premises are only supplied with one phase.



Complete 3 phase converter installation. Note the "no load" motor on the floor (see text) and the machine tool light, fed from the single phase source. NB some wiring in this photograph is of a temporary nature.

WORKSHOP

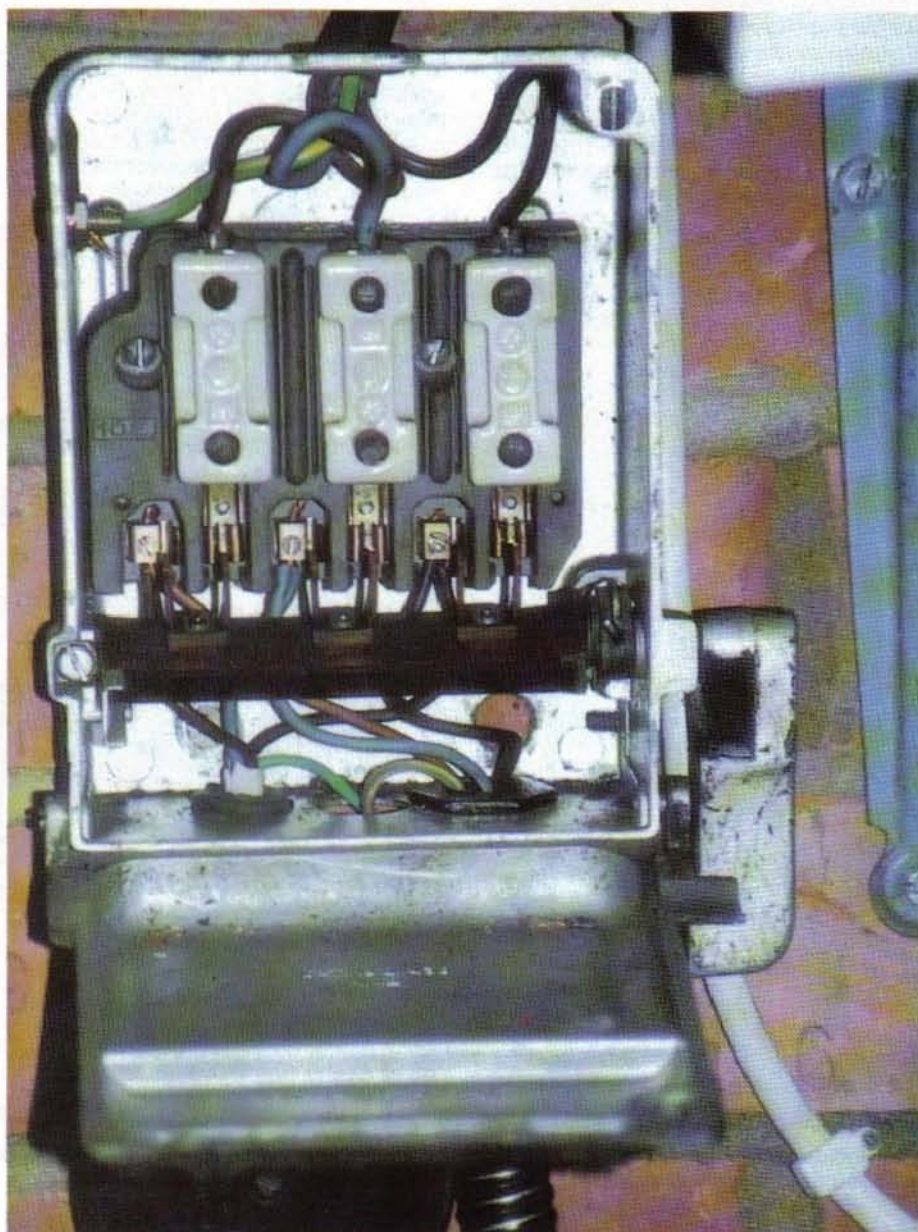
certainly have cut down on the spindle speeds available.

Other advantages of three phase motors are:-

- Easier starting.
- More powerful at the equivalent HP than single phase motors.
- More reliable.
- Easier reversing.
- Cheaper to run.
- Cheaper to purchase (particularly second-hand).



2: A 3 phase fused isolator. Note the fourth earth continuity conductors connected to the case. 3: The author's milling machine which led him to investigate a 3 phase supply. The motor which is integral with the gearbox would have been extremely difficult to replace with a single phase one.



As far as this last point is concerned the local scrapyard could be a mine of spare motors and a little haggling will provide all that is required, usually with an offer to exchange the unit if anything proves faulty when it is run.

How to achieve a three phase supply MAINS

The obvious first choice is to approach your local electricity board and ask for a quote to convert the house supply to three phases. The cost will of course vary enormously depending on the length of the drive and whether concrete has to be dug up and replaced.

A yardstick for the work in urban areas is £400, but this is likely to rise to prohibitive levels in rural locations. To this must be added all the switchgear and cabling on the consumer's side of the meter to bring the supply to the workshop itself.

GENERATOR

The next possibility is a three phase generator. Small three phase units are difficult to obtain and the cheapest quote the author could obtain was £750 for a 3kw generator. This does have the additional advantage of providing an additional power unit for the house itself in the event of power cuts, or for camping etc., although a 3kw unit is not very portable.

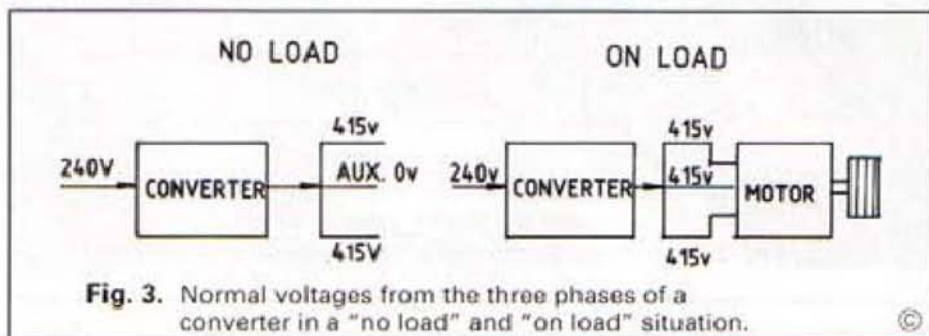
The disadvantages of generators are firstly noise. The neighbours may not object to model traction engines complete with whistle in steam at the weekend, but the noise of a generator during a late night session in the workshop may be a different matter! If the generator is housed inside to overcome the noise problem, then exhaust extraction and cooling must be considered.

Secondly, a generator will always be more expensive to run than mains electricity, although this may not be significant in many cases. If a three phase generator is used to supply single phase equipment it is important to balance the load across the three phases as far as possible.

CONVERTER

The third option, which is often ideal for the small workshop, is the purchase of a three phase converter. This is a small box containing static circuitry which will convert a single phase supply to three

N.D. Electrical of 29-35 Holly Road, Twickenham, Middlesex TW1 4EA, telephone number 081-892 2722. Not only was the price of £147.58 for the 2 HP model very reasonable, and less than half the estimate for the local board connecting a three phase supply, but in addition the service was excellent (usual disclaimer). To save the delivery charge the unit was collected and the comprehensive manual was explained in detail. In addition, an after sales technical advice service was freely available by telephone.



phases, and the unit can be located in the workshop itself. There are no exhaust fumes or rotating parts to worry about and models are available to cope with loads of between 2 and 20 Horse Power (HP).

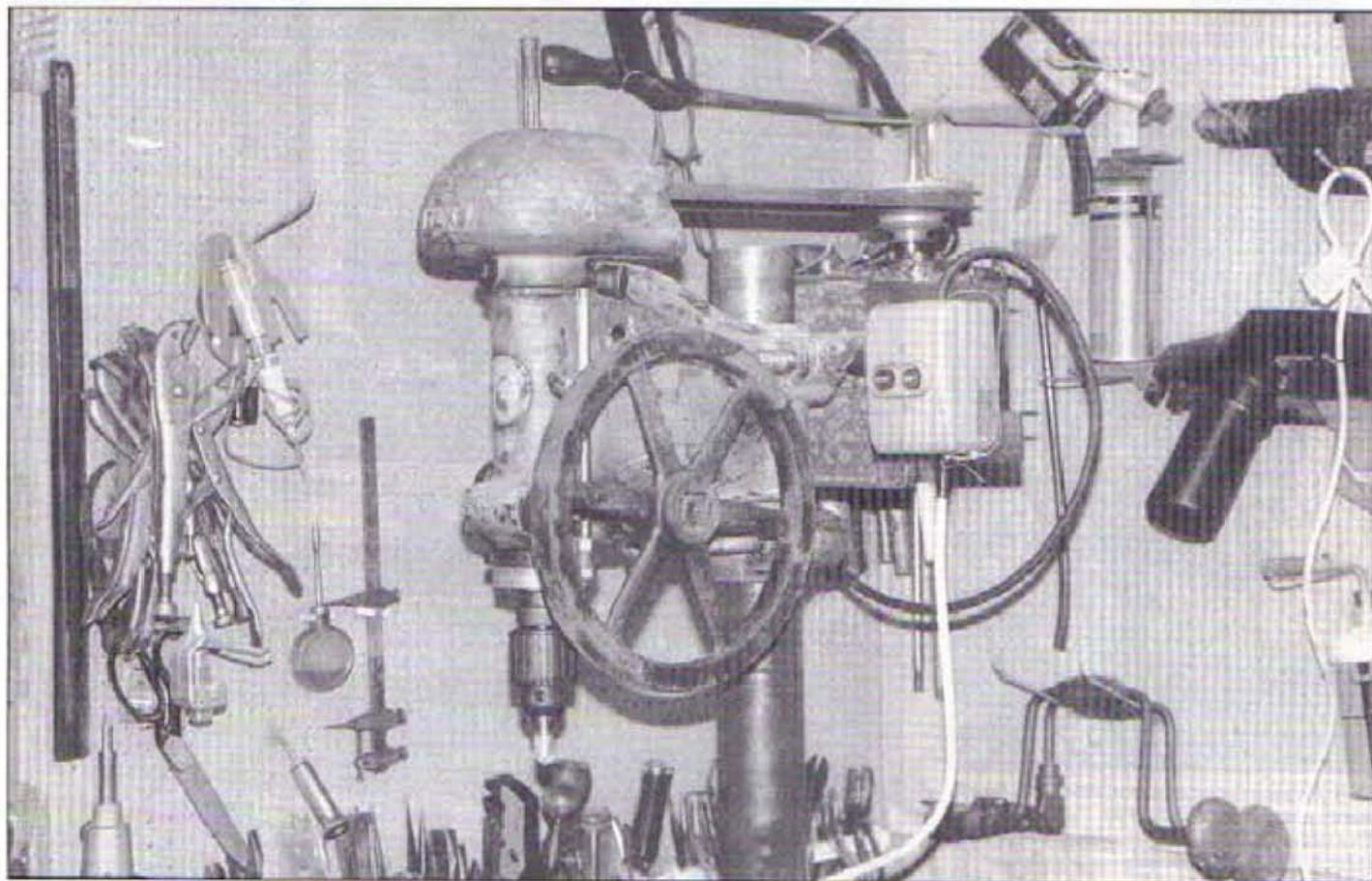
In practice, the smallest 2 HP model converter will almost certainly be sufficient to run everything required in a home workshop, where only one machine tool is likely to be running at any one time.

A number of different firms advertise these converters in the pages of this magazine, but the author obtained his from

Three phase converters in operation

Although the final results were excellent, a converter is something of a compromise and it is as well to understand its limitations before moving too far with the conversion of the workshop. Unless a neutral is specified when ordering, the unit will be delivered with four output wires - three phases and earth.

The vast majority of three phase motors are delta wound, which means that no neutral is required. This does however



This drilling machine complete with three phase motor was purchased for £10. An example of how cheaply a workshop can be equipped with surplus industrial equipment.

mean that any single phase ancillary equipment, such as a machine light, must be run from the normal mains and not the converter, which will only supply 415 volts.

Although the converter has three phase wires, one of them (normally coloured blue) is termed the auxiliary phase and this only becomes live after the motor has started to turn. (See **figure 3**). This can lead to starting problems, particularly where the motor has a high initial load or starting torque. To overcome this, the converter is supplied with an initial power boost for approximately three seconds until the motor picks up to its normal operating speed. In addition, a manual boost switch to provide extra power at any time is provided, but this must not be held down for more than a further three seconds to avoid damage to the unit.

Normal single phase input current to the converter is approximately 3-4 amps per HP, so the unit can safely be run from a normal 13 amp supply connected to a ring main, but while the boost power is supplied, current surges to 15 amps or more, which is right on the limit of such circuits. If the converter is to be used during the winter when a heavy heating load is being taken from the workshop ring main, then a separate radial circuit should be considered.

On the 2 HP model an additional control is supplied which is set to give the most even running of the motor. It is surprisingly easy to find the correct position for this switch as the motor will run easily with the correct setting, but the noise level is much higher on the other two settings. The purpose of this switch is to compensate to some extent for running a small motor of say 1/2 HP with a 2 HP converter.

With such an underload the motor will run quite well on setting 1, but investigation will show that there is a considerable variation between the three phase voltages and one could be as high as 500 instead of the nominal 415 volts. ND Electrical will supply a special low HP model on request to overcome this problem, but a far better procedure is to have an extra motor in circuit, which will run on no load whenever the converter is switched on. This will draw very little current, but will ensure that the blue auxiliary phase is continually live at 415 volts so that when a machine tool motor comes into circuit it can start under load without difficulty. The combined power requirements of the two motors will then mean that all three phase voltages will be much nearer the 415 volt nominal figure. (See **Fig. 3**).

An additional advantage of a 'no load' motor is that there is no problem on the wiring of starter solenoids. Readers of the article in the last issue will remember that IEE regulations call for "Every motor to be provided with means to prevent automatic restarting after a stoppage due to a drop in voltage or failure of supply, where unexpected restarting of the motor might cause danger". This requirement is met by the use of a solenoid which holds the contacts together while the mains voltage is present, but which drops the contacts on a power failure and then requires manual resetting.

On a single phase supply this solenoid is wired between live and neutral, but on a three phase supply the feed is between two of the phases (commonly, but not

exclusively, the outer two terminals on the starter input). In the case of a converter the solenoid must be connected to the black and brown converter wires as the blue auxiliary phase will not be live on starting and the solenoid will not hold in if the blue is used to supply one of its terminals. If, on the other hand, a 'no load' motor is used, then the blue will be live and the solenoid will operate on any two phases. It is however good practice to always wire the solenoid to the black and brown phases.

Three phase wiring and safety

If a three phase motor rotates in the wrong direction, reversing any two of the phase wires will change the direction of rotation. This characteristic can be very useful if a reversing facility is required on a machine tool, and a simple reversing switch can be wired into the circuit. As far as fusing is concerned, ND Electrical advise that, providing the single phase supply is protected by a 13 amp fuse (for the 2 HP model), any short circuit on the three phase side of the converter will blow this fuse and not damage the converter.

A three phase fused isolator is, however, a useful additional safety feature. It is good practice to run all machine tool motors via starters and these incorporate circuit breakers which operate on excess current. It is, however, important to match the rating of the starter to the full load current of the motor. Most starters have the ability to adjust the full load current setting, but only over a limited range. A typical wiring diagram is shown in **figure 4**.

Apart from the above, three phase

wiring and safety is no different from single phase. All appliances should, of course, be earthed in the normal way, but a converter will not give a 240 volt reading between each phase and earth and no significance should be read into this fact.

QUICK TIP

Most workshops probably have some sort of low voltage D.C. supply to run mini drills and low voltage motors. Equally useful is the facility to vary the A.C. Mains voltage and variable voltage transformers - Variacs are very convenient for the purpose. They are expensive in the size really required which is probably 8 amp rating. Variacs are sometimes available surplus or you might find one in the residue of one of the small business that regrettably are shutting down in the recession. With a Variac the output voltage can be continuously varied between about 270 volts and zero and they can be used with most sorts of equipment, heaters, motors (only AC motors with brushes and commutators can have their speed varied by varying the applied voltage. Other AC motors can only have their output torque controlled. See *Model Engineer* 20 Sept, 3 Oct 1991 ED). etc. (although fan cooled motors may overheat if run too slowly).

J. Jennings.

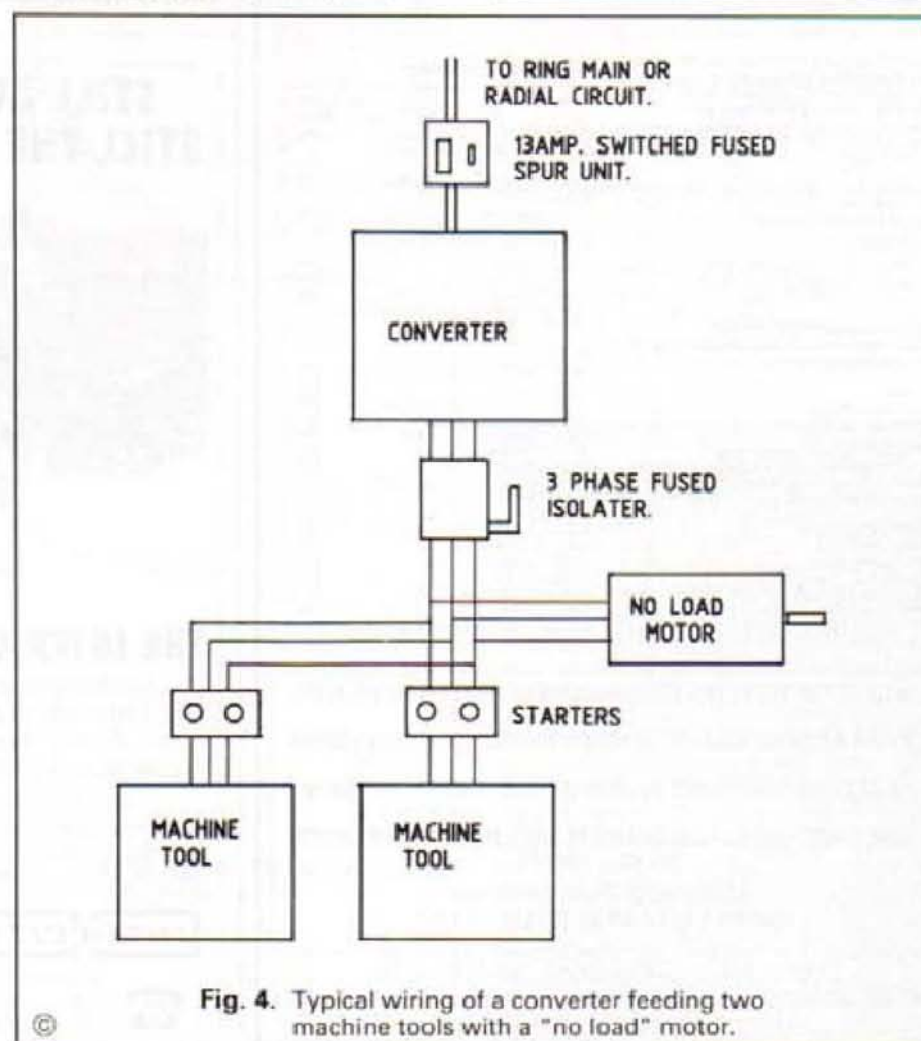


Fig. 4. Typical wiring of a converter feeding two machine tools with a "no load" motor.

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1/4 x 4" sq	£10.00
1/4 x 2 1/2" sq	£6.00
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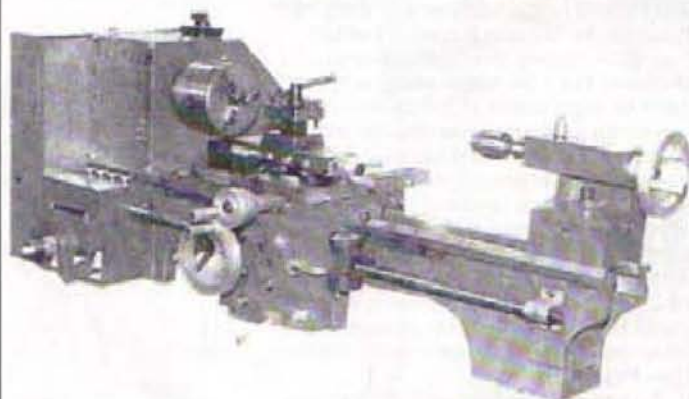
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The disc being cut using a makeshift dividing unit.

only one display is tested at a time.

To test the power supply it will now be necessary to connect the mains to the 240V terminals on the transformer. The 6V terminals on the transformer are then connected to the A/C IP terminals on the power supply assembly.

UNDER NO CIRCUMSTANCES HAVE THE TRANSFORMER LYING OPEN ON THE BENCH WHEN SWITCHING THE MAINS ON. To avoid this, use a small cardboard box complete with lid, place the transformer in this with the lid closed before switching the mains on. With this arrangement all that is necessary is to measure the DC voltage to ensure that this is around 5V.

The DC power supply tag boards

Finally the two small DC power supply

DIGITAL READOUT

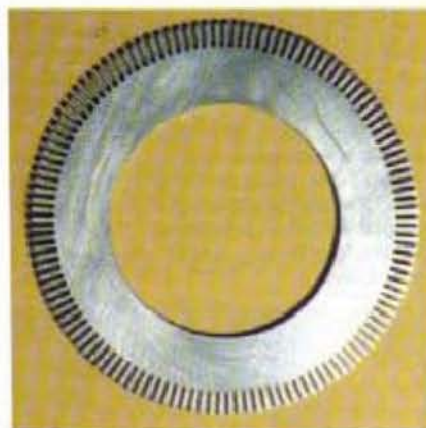
Having completed the major electronic assemblies in the last issue, it remains only to make the power supply, and the DC power supply tag boards, to complete the sub assemblies.

The power supply

Now, with all the major assemblies constructed and working, there remains only the power supply to be made and tested. This is quite straightforward, but do observe the drawing relating to the mounting of the regulator. This position is vital for the eventual assembly onto its heat sink.

The purpose of the heat sink is to ensure the component does not overheat when being run for long periods. It will not be essential for the initial testing, providing

This is the concluding part of our Digital Readout article; if you have already decided this is not for you, please read the author's final paragraph before finally deciding against making this rewarding item



A close-up of the pulse generator disc.

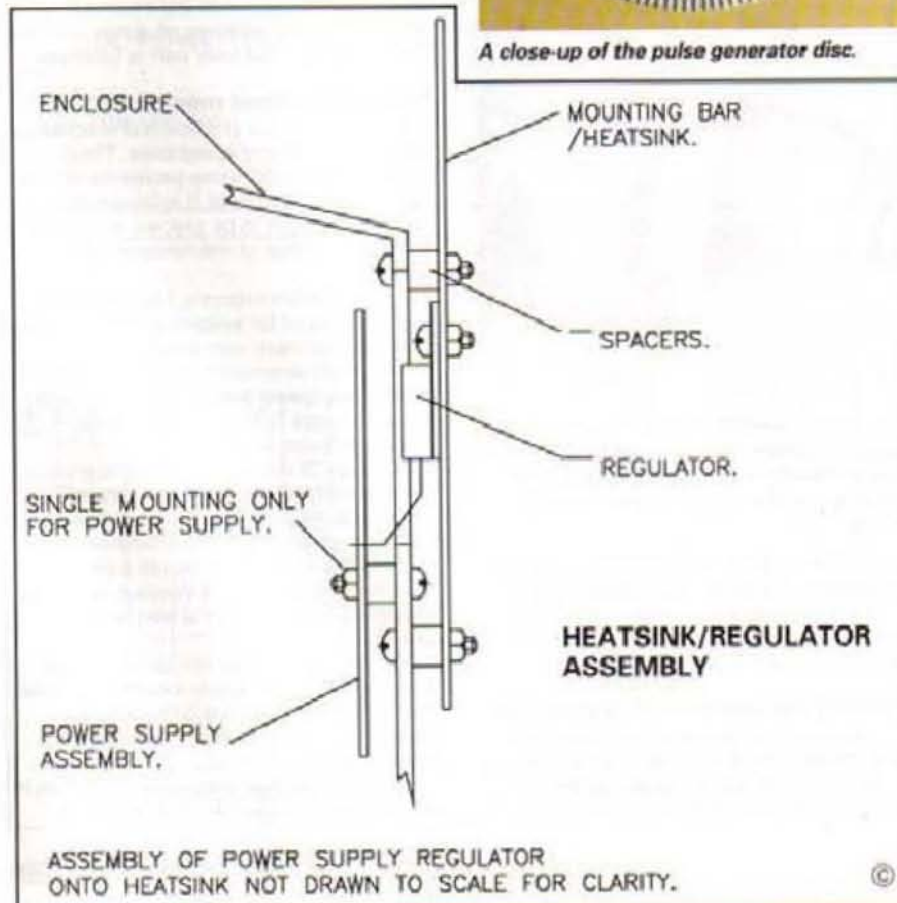
tag boards remain to be constructed; the requirement for this can be seen in the drawings. These are to be used when the assemblies are eventually installed in their enclosures. Their purpose is to enable the power rails to be easily connected to the numerous places required.

Having now completed and tested all the individual electronic assemblies, the following remain: Assemble and wire the digital display units, construct and install the pulse generator assemblies, and install the interconnecting wiring ready for final testing and eventual use of the system.

Packaging the electronics

With the electronic assemblies now complete and tested, there remains some simple packaging of the electronics, together with the associated wiring. **DISPLAY UNIT MECHANICS**

First complete the display assembly mechanics; this should be found quite straightforward. The mechanical



Parts availability

Since publication of the first part of this two-part project in our last issue (MEW Dec '91/Jan '92), we've heard from J.W. Cahill of Hybrid Engineering Design Ltd., Glasgow who can supply certain essential components for the Digital Readout. Mr. Cahill writes: "We are able to supply encoder discs suitable for the design in both 100 and 125 slot versions with an O/D of 1.875 in. and a bore of 0.875 inch. The material of manufacture is 0.5mm stainless steel and the cost will be £12 per disc or £22 per pair plus VAT and postage."

"We are also happy to supply the pulse and direction shaping printed circuit board at a cost of £8 plus VAT and postage."

If you wish to order or require more details, Hybrid Engineering Design's full address is 119 Yokermill Road, Yoker, Glasgow, Scotland G13 4HL. (Tel 041 952 5201)

requirements are all covered by the drawings and/or the photographs, and should be easy to follow. No assembly drawings are included in the article, other than for the power supply heat sink assembly, and the method of fitting the display and counter assembly to the rear of the front face.

The photographs should give adequate indication of how the remaining components are positioned. Take note though – some details have been tidied up in the drawings, and therefore minor differences do exist from the prototype as photographed.

The mounting bar on the left hand box also doubles as a heat sink, this for limiting the regulator to an acceptable temperature.

Do ensure that good contact is made between regulator and heat sink, and without undue strain being placed on the printed circuit board itself. Strain, if present, may result in the track being lifted from its surface.

The lower fixing foot on the transformer will require bending to accommodate the curve at the lower rear of the box. When fixing the transformer, use a screw in the top foot, long enough for a washer and nut to be used, to fix the transformer, plus sufficient length for the various earth connections that use this as a central earth terminal.

Fix all the earth connections by a second washer and nut. Adopting this method ensures that all connections are terminated between two nuts, thereby excluding the plastic box which may deform with time and the connections become loose.

Do conform to the circuit shown for earthing including that for the screen leads. This is essential to ensure that the sensitive electronics do not suffer from stray pick up voltages.

One essential feature THAT MUST BE OBSERVED, is the shrouding of the high voltage terminals, both on the transformer and on the 'power on' switch.

This is a vital safety requirement, as during any subsequent testing the enclosures will be open and these terminals alive. The prototype has been shrouded using heavy duty insulation tape and some additional cover over this would be preferable.

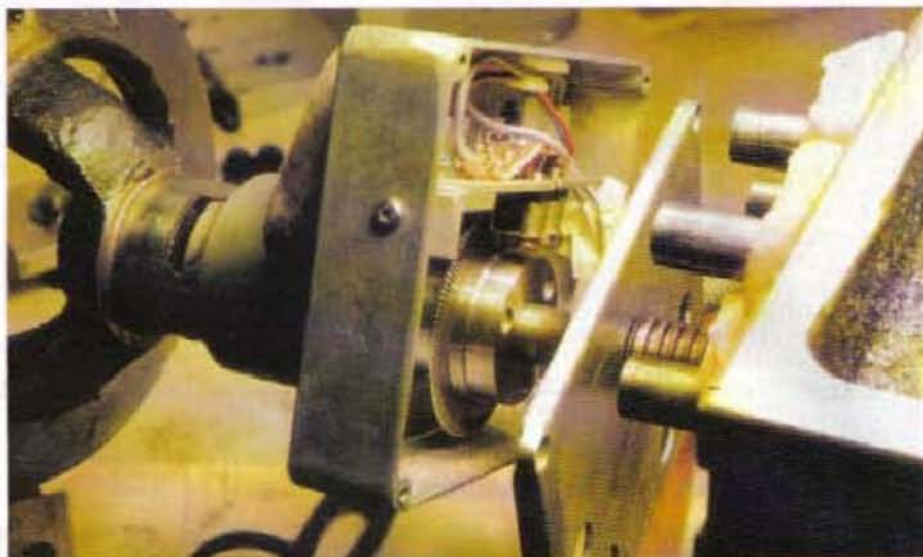
The main terminal strip is fixed using self-tapping screws. The additional smoothing capacitor mounted in the right hand enclosure (removed in the photograph to enable the pulse shaping assembly to be seen) can be held in place using the foam filled double adhesive tape also used elsewhere. Otherwise all assembly requirements not covered by the drawings should be obvious.

Having completed the assembly of the display unit it is now ready to have its internal connections made.

The wiring diagram is drawn with the front panels upside down as this is the easiest position for wiring. This position is achieved with the panel fitted on the two lower fixing screws and hanging down, as can be seen in the photographs.

THE DISPLAY UNIT WIRING

For those not familiar with the conventions for wiring diagrams, these are not drawn to scale but show only a rough layout of the unit. Also, whilst the connections should interconnect terminals exactly as indicated, the route taken between the two terminals is at the



The table pulse generator in the final stages of being fitted to the unit.

discretion of the wireman. Having said that, in this application the drawings probably do approximate to that scheme which will be found easiest.

The cable colours indicated are, of course, not essential but using different colours will help with tracing connections throughout the unit.

Do use for the mains cable, the strain relief indicated in the parts list. Should this be found unsuitable for the mains cable to hand (this is not included in the parts list) then ensure some other adequate strain relief is employed.

As 13 amp plugs are invariably supplied with 13 amp fuses, there is a great temptation to leave it this way. Do ensure that the fuse fitted is rated 2 amp or at the most 3 amp.



The pulse assembly finally fitted to the table. Adhesive foil was used to seal the top of the box/table interface to prevent the ingress of unwanted swarf, cutting oil etc.

With the display unit now internally fully connected, it is preferable to test the unit as a whole, prior to proceeding with the final stage, being the machine mounted pulse generator assemblies.

Testing the completed display unit

Take one pair of opto switch assemblies and connect these into the screw terminals A, B, 5V and 0V, generally as had been done before when testing on the bench.



The table bearing mounting posts and the extended leadscrew.

The display should now function fully, that is with leading zeros displayed, decimal point in position, reset button working, and the display able to count both up and down.

Transfer the opto switches to other display terminals to test the second display. With the display working, sit down and take a deep breath – the easy part is finished!

The pulse wheel mechanics

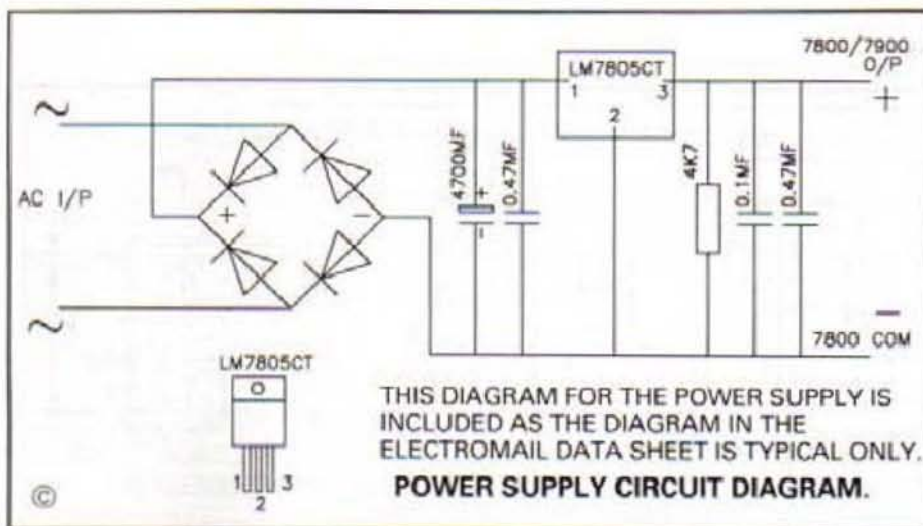
At last we arrive at some real mechanics, the pulse generator assemblies. These present some interesting problems of their own, but unfortunately, it is here that it becomes difficult to be precise, in view of the diverse range of machines to be considered.

Working from memory, I consider the vast majority of far eastern machines I have seen have all been very similar in construction around this area. Therefore the method being described in the article should be able to be employed, very closely for most cases.

The type of die cast box used to enclose the assembly, is available in a very wide range of sizes. The one chosen was arrived at, largely due to its being shallower than most of the others. This would limit therefore the amount by which it would be necessary to space off the lead screw bearing.

Whilst space is very limited inside the box, increasing the depth would be of little help; another 1/4 inch would have been beneficial, but the next size up was much more than this.

Readers who feel they have a problem in this area could consider other sizes. All



three suppliers listed in this article have a wide range of boxes listed, as do other suppliers such as Tandy, and Greenweld (27 Park Rd., Southampton SO1 3TB. Tel. 0703 236363).

In the main though it is the presence of the internal spacers that have to be added that create most of the problem. An alternative to the spacers would be to use a piece of channel, but the advantage of the spacers is that, providing they are all the same length, it is easy to ensure the lead screw bearing remains in line.

This alternative arrangement is shown in limited detail, as it may be of interest to some who wish to proceed but are not happy about the cramped conditions inside the box.

Apart from the sketch mentioned above, indicating an alternative, this article will now proceed purely with the method adopted for the prototype, leaving the reader to consider the alternatives if found necessary.

The table pulse wheel enclosure

The lengthways feed will be considered first, as this is likely to have the most problems. When this is completed, the other axis should appear quite straightforward. (See postscript).

It first has to be decided which end of the screw the pulse unit will be fitted, and the end without the index dials was chosen, this also being the end that does not include the thrust bearings. Whether

this choice has any advantages or disadvantages has not really been considered.

First dismantle the lead screw mechanism completely and, with this done, proceed to make the posts to stand off the lead screw bearings. These posts should be $\frac{1}{16}$ inch longer than the external depth of the box chosen, and should also be all the same length to within a thou., this to ensure that the bearing remains in line.

If considered beneficial, the posts can also be waisted to create more room for the opto switch assemblies. Make the posts for the other axis at the same time, as they are identical.

Now fit the posts to the end of the table and measure the centres of these, together with the lead screw. Transfer these dimensions to the box, followed by drilling the box and lid so that it will slide into position over the posts.

Do ensure that the box is drilled for the base of the box to be mounted against the lead screw bearing, and not the table. This is the position to be adopted for both housings.

The spacing of these posts was very irregular which made this process more difficult than anticipated. Do not be tempted to drill all holes oversize as there is no fixing for these boxes, other than some double adhesive strip.

Should the boxes move in use, not only may this affect the reading being taken at the same time the box moves, it will cause the relationship between the two pulse outputs to shift. The change from the $\frac{1}{4}$ cycle difference as discussed earlier, will result in the unit requiring resetting.

A good approach would be to fit two posts only, measuring their centres accurately and to drill the box for these with close-fitting holes. Make any adjustment carefully using a small half round file, until the box just slides over the posts, without movement. The remaining holes can now be drilled with an adequate clearance.

Extending the lead screw

The lead screw itself will now require extending in length, in view of its bearing being stood off on posts, to accommodate the thickness of the box.

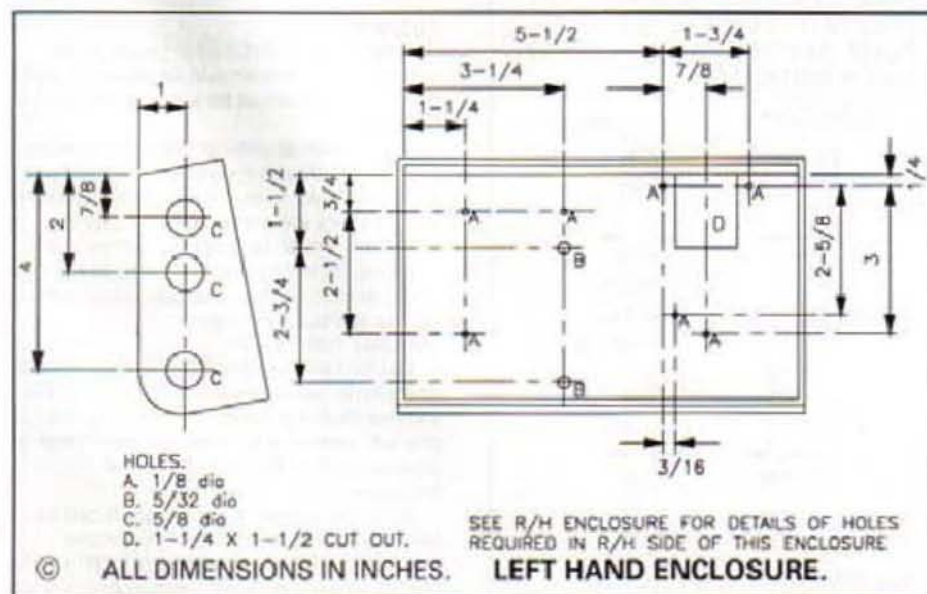
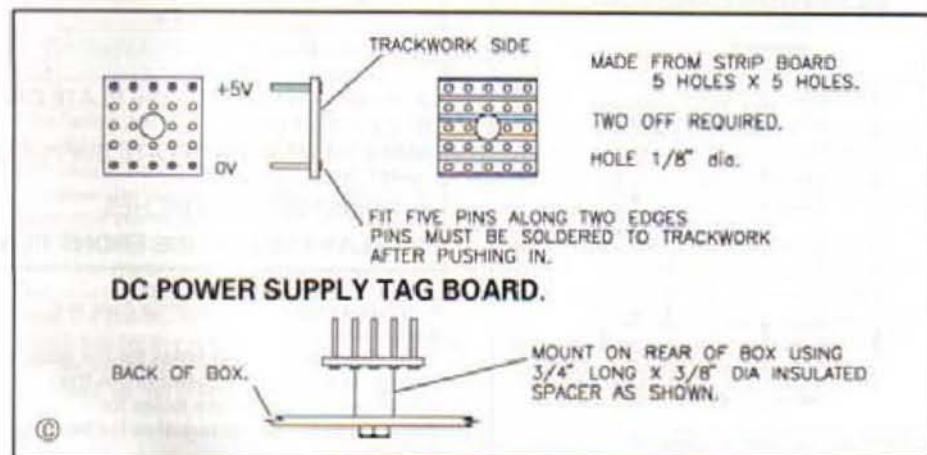
To record the length actually required, measure the length from the end of the lead screw thread to the end, and add to this dimension the extension required. Make a note of this value for reference later.

For most people, the screw will be too long for it to be held in the chuck, and the outer end to be machined whilst supported in the fixed steady. To overcome this situation remove the tailstock and place the end to be machined in the chuck, with the other end supported in the fixed steady.

Hold just enough in the chuck for safe working, also preventing undue strain on the chuck jaws. Machine a waist on the lead screw as indicated in the drawing and part off.

Now take a length of steel, about $\frac{1}{16}$ inch larger in diameter than the lead screw parallel portion, and around 3 inches longer than the extension required. Bore this to be a close fit on the reduced diameter section just produced on the end of the lead screw.

As this is to be fixed to the lead screw, using adhesive, it will help to relieve the



pressure generated when fitting to bore this hole at least $\frac{1}{8}$ inch deeper than required; alternatively, a small hole could be drilled right through.

Fit the parts together using two-part resin adhesive, and if possible place in a warm position to achieve maximum strength. When set return the assembly to the lathe, holding the extension in the four jaw chuck, the other end again supported in the fixed steady.

Adjust the four jaws of the chuck so that the original bearing portion of the leadscrew is running perfectly true. Now reduce the diameter of the added portion until it is equal in diameter to the plain portion of the leadscrew. Follow this by parting off to the required length of extension, as per dimension recorded earlier.

Reassemble the whole arrangement, but with the bearing now on its stand off posts. As it is likely that the outer bush is fitted using a roll pin, redrill the leadscrew through the bush to accept the pin in the new position. Temporarily fit the pin, to ensure that this stage of the modification has been completed satisfactorily.

The lower pulse wheel enclosure

With the first pulse unit empty housing satisfactorily installed, the second axis must be attended to. This should be much less of a problem on two counts. Firstly, as the leadscrew has no bearing at its non-handwheel end, and is unlikely to have been made only just long enough, this will not need extending.

Secondly, the bearing unit is normally fitted with just two screws, and in a manner that will not impede the fitting of the opto switches; as a result there should be much more room.

On this basis, there is nothing to add, other than to say the arrangement conforms generally to that of the first. The relative simplicity of this arrangement can be seen in the photographs. (This was in Part 1).

Pulse unit internal construction

The internal parts for the actual mounting of the opto switches now require to be made. With the boxes having been drilled for the bearing mounting posts and the leadscrew, the available space inside can now be seen.

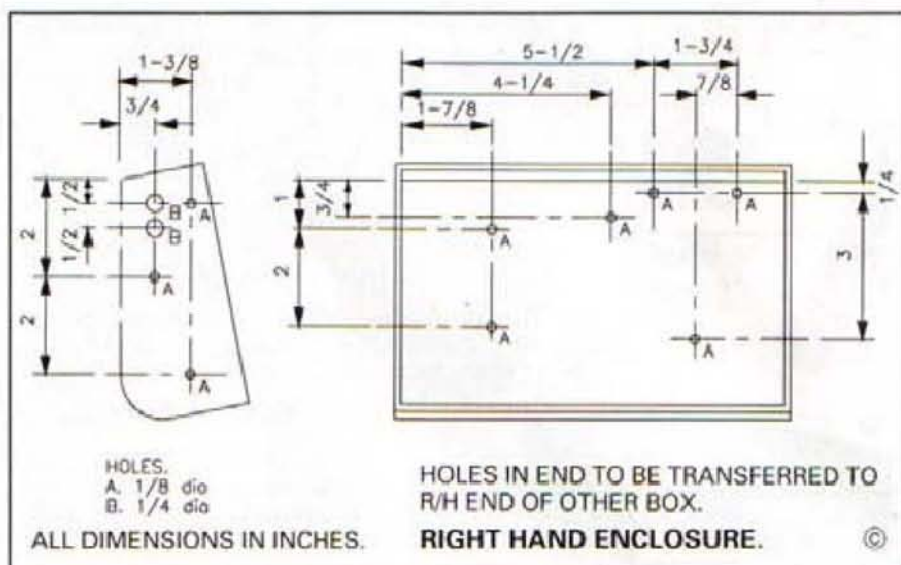
This should be considered very carefully and any adjustments to the dimensions for the opto switch mounting parts, as shown in the drawings, decided on at this stage. Also the diameter of the pulse wheels should be considered and confirmed at this stage.

With these facts having been finalised, proceed with the manufacture of the remaining parts, either as per drawing or as per the conditions that have been established as necessary for the application.

It has been considered preferable not to attempt to produce dimensioned drawings for the drilling of the boxes. Therefore with the inner parts completed, transfer the positions for the required holes from these to the boxes as required and drill to suit.

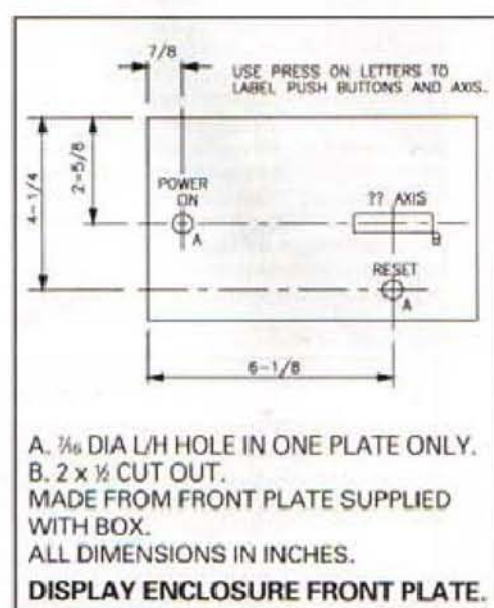
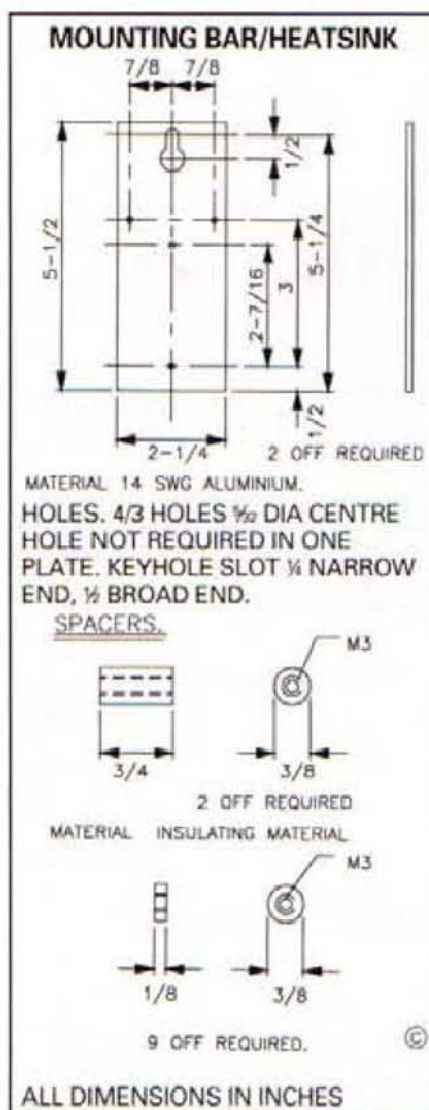
Pulse disc carriers

Follow this by producing the pulse disc carriers and clamp rings. When machining the carriers, do machine all the important faces, including the bore, at one setting, this to ensure that the disc will run true.



Take note of the requirement for the section that locates in the disc bore to be longer on one carrier in the first place. The purpose of this is to enable it to be used to carry a number of disc blanks at the same time, during the various stages of machining these.

Make sure that you measure both leadscrew diameters before producing the two carriers, as they may be different diameters. The clamping is less important



as it has a generous clearance over the leadscrew.

Drill and tap the two holes for the grub screws used to fix the assembly to the leadscrew, also the three holes for clamping to two parts together for holding the pulse wheels.

Pulse wheels

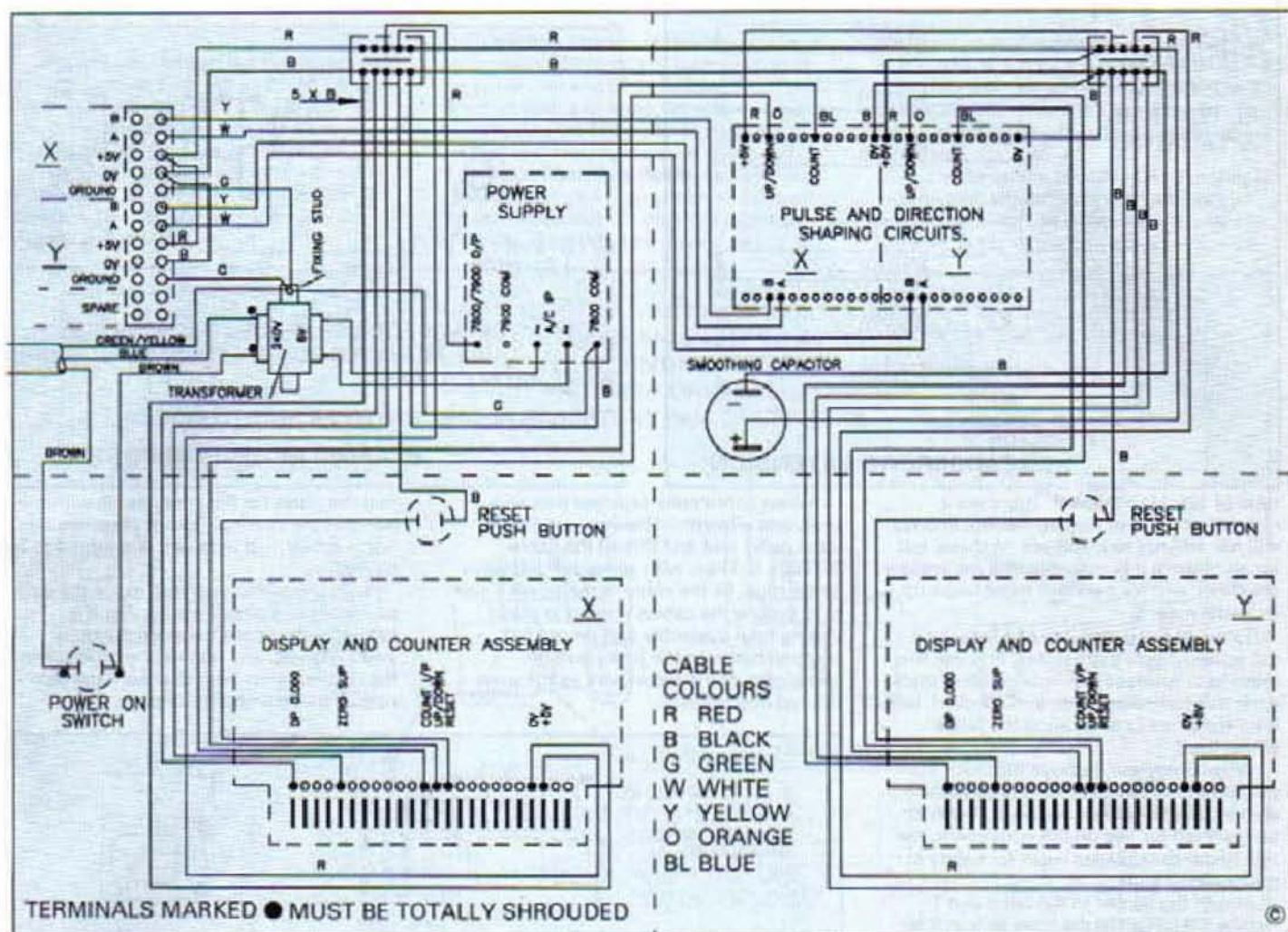
Locate some material to produce the pulse wheels; this should be about 15 to 25 thou thick and could be steel, aluminium or brass.

As it is just as easy at the same time to make more than the two required, cut enough blanks to make, say, five. This will ensure there are some spares if any get damaged, which is possible as they are a little fragile. In any case, the disc at the rear of the pack is likely to have burrs on it that will be tedious to remove.

MAKING THE DISCS

Cut five blanks about 2 1/2 inches square, drill a hole through each at the centre. Fix the five together using a screw and nut; this will make it a lot easier to hold them in position, whilst fixing them to the faceplate.

With the screw long enough, it can be held in the drill chuck mounted in the tailstock making it very easy to position the blanks whilst clamping them in position on



the face plate. Carefully bore out the blanks, until a close fit on the disc carrier is achieved. Having arrived at this stage, remove the blanks from the faceplate, that will now come away as individual parts.

Carefully remove the corners, this to limit the material to be removed when returned to the lathe. Ensure at all times that the blanks remain flat and are not distorted by the cropping off of the corners, or the initial cutting of the blanks.

Place all the blanks on the disc carrier,

and clamp tightly with the clamp ring. Now with the chuck returned to the lathe, fitted with a suitable piece of steel just larger than the bore of the carrier, turn this to be a close fit in its bore.

Fix the carrier, together with rough blanks, using the grub screws intended for the eventual fixing of the carrier to the leadscrew. Carefully turn the blanks to the required diameter and remove the assembly from the mandrel but do not remove the discs from the carrier.

PRODUCING THE DIVISIONS

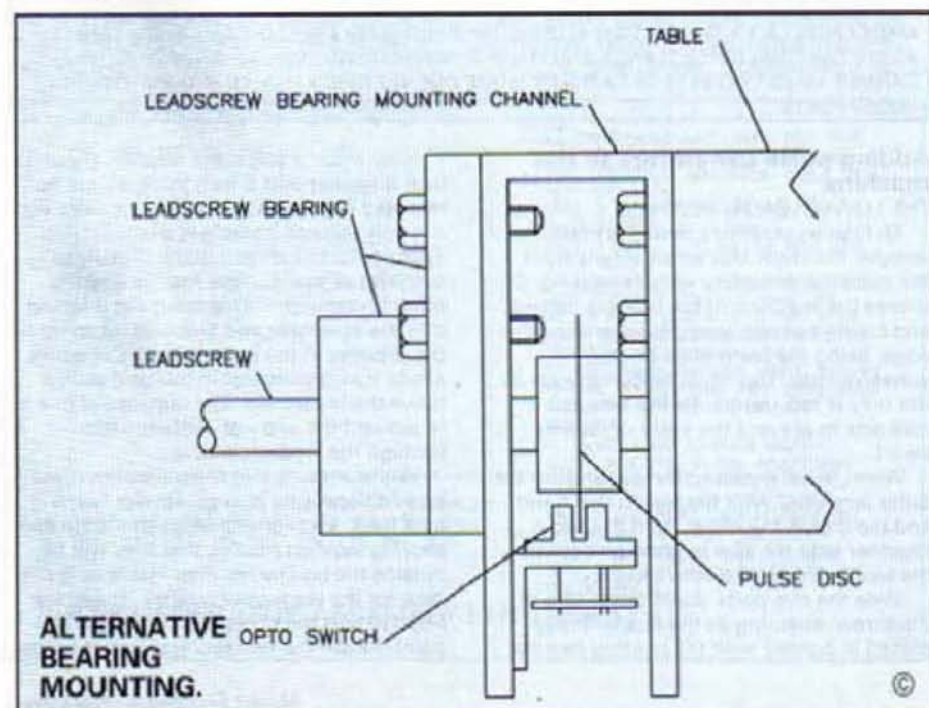
Whilst the discs are still in the carrier assembly, they should be transferred to the dividing setup. This is obviously going to vary considerably from one person to another and would be pointless to discuss in detail. That shown in the photographs was rigged up from some scrap components, salvaged from a totally different industrial application.

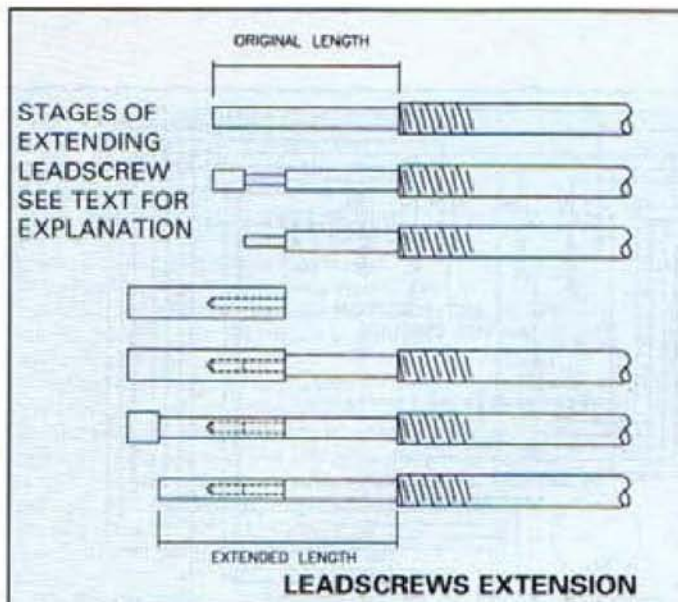
The method of achieving the division is likely to be the greatest problem, for those requiring a division of 125 steps. Firstly, therefore, considering the requirement for the easier to achieve 100 pulses per rev, this can be arrived at using a 25 or 50 division disc, and the additional circuit mentioned earlier, or a 100 division disc. The 100 divisions can be created using a 50 tooth lathe change wheel and using a rotatable plunger.

This will locate between two teeth in one position and, when rotated 90 degrees, has a two pronged fork-like end that positions itself across a tooth. This method is able to index the 100 divisions, by being able to hold the wheel, both in the space and the tooth positions.

For those without any form of dividing facility the most probable method for achieving the 125 divisions is by employing a gear train using the lathe change wheels. The spindle on which the discs being divided are fitted, has also a 75 tooth wheel fitted, this being driven by a 30 tooth wheel, on the same spindle as a 50 tooth wheel.

By indexing one tooth at a time, on the 50 tooth wheel, and with the ratio of 2.5:1 from the 30 and 75 tooth wheels, a dividing





ratio of 125:1 is achieved. There are a number of ways of rigging this up, and we will not attempt to elaborate on these, but for all of them it is essential that the wheels are clean, and for backlash to be taken up by some means.

To avoid the possibility of a failure on the pulse wheels themselves, first use this method to produce a simple dividing plate. After this has been made and checked, use it for the process of creating the pulse wheel itself.

When complete, remove the discs from the carrier, and inspect for any obvious errors; hopefully there are none. Two can be reserved for use on the equipment, the remainder then placed away for safety in case needed later.

Return the carrier to the lathe and reduce the length of the boss so that it is now suitable to carry a single disc as shown in the drawing. Assemble the two wheels, together with their carriers and clamping rings and place in a safe position as the pulse wheels will damage easily.

The final installation

We are now left with the assembly of the pulse generators, fitting them onto the machine and interconnecting with the display unit, followed by final testing. Before taking this step, it is worth assembling the pulse units, making temporary interconnections on the bench, to make one last bench test before final installation.

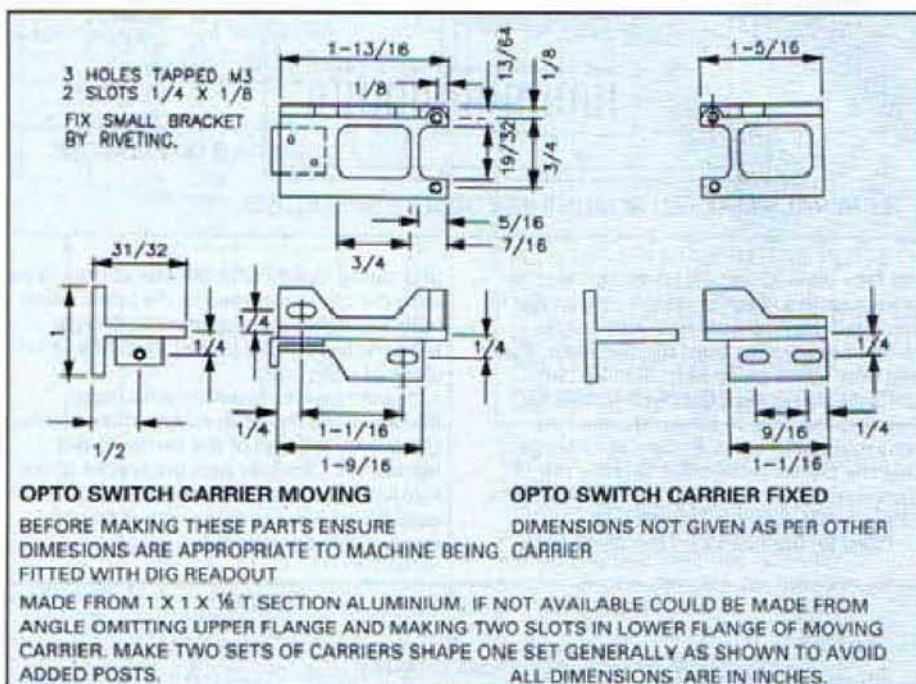
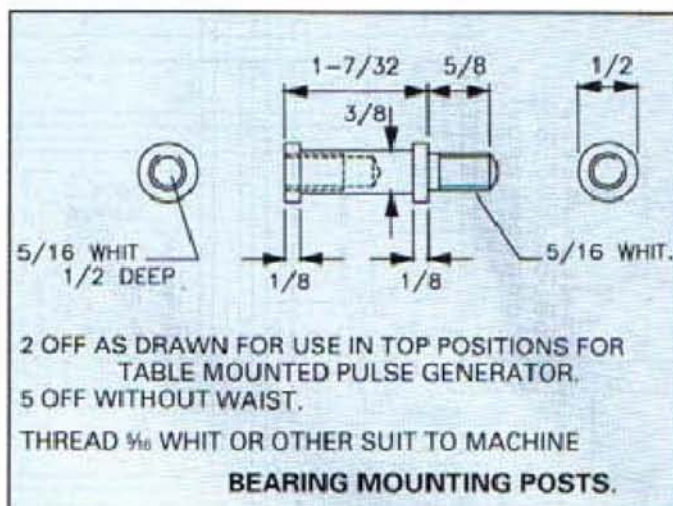
Assemble the opto switches onto their carriers, and take a length of the four core cable of sufficient length to eventually connect to the display unit in its final location. Make off the connections at the pulse unit end, in a final manner, adding also the power rail interconnections between the two opto switches, all as shown in the interconnection diagram.

Make sure that the screen is not connected to any terminal at this end, neither should it be touching any metalwork; using insulating tape or sleeving may help to ensure this. When complete, but still on the bench, connect the other end of the cable into the terminals in the display unit. Rig up the pulse disc on a temporary spindle and run this between two V blocks with the disc in position in the two pulse generator assemblies. Rotate and check that the display functions correctly. The pitch between the two opto switches will require adjustment. Connect cables to the second unit and test in the same manner.

When completely satisfied that all is well, add a length of flexible conduit to each pulse unit and thread the cable through it. Then, with some self-adhesive cable clips, fix the cable in the boxes - this is to ensure the cables remain in place during final assembly and do not get trapped between the posts and the remainder of the metalwork as the units are fed into position.

that the holes for the post line up with the holes in the bearing. Do not press the box home firmly, just in case it is required to be moved.

With the box in position, move the disc assembly to a position such that it is central in the space between the opto switch halves, and tighten the grub screws. Rotate the handwheel to ensure the disc rotates freely without rubbing.



Adding pulse generators to the machine

THE LOWER LEADSCREW

To finalise assembly onto the machine, remove the lower lead screw totally from the machine, complete with its bearing. Degrease the rear face of the bearing casting, and create a continuous gasket around the edge, using the foam filled double adhesive strip. This must be continuous as not only is this used to fix the box, but it also acts to prevent the entry of dust or swarf.

When fixed, removed the paper from the outer face also. With the box in one hand and the disc in the other, hold the two together with the disc in position between the two halves of the opto switch.

Slide the two parts down the length of the screw, ensuring as the box is finally placed in contact with the bearing casting

Now make a soft foam washer, about 1 1/2 inch diameter and 1/8 inch thick; do not be tempted to make it thicker on the basis that it is soft and will compress easily. Experience has shown that it is likely to break up as one surface rotates and the other is stationary. This results in it falling into the assembly and blocking up some of the grooves in the pulse wheel. Cut a hole about 1/2 inch diameter in this and slide it down the lead screw. The purpose of this is to prevent the entry of contamination through the lead screw hole.

Whilst making this foam washer, make an additional one plus six similar but 3/8 inch thick. Slide one thick washer onto each bearing support post so that they will be outside the box rather than inside as is the case for the lead screw washer. These are fitted to seal the holes into the box at this point. Retain the remaining washers for the

other unit.

Take one final look in the box to see that all appears well, slide the lid down on the screw and fix in position. Take one final look in the holes into which the posts are to enter to ensure they are free of cable.

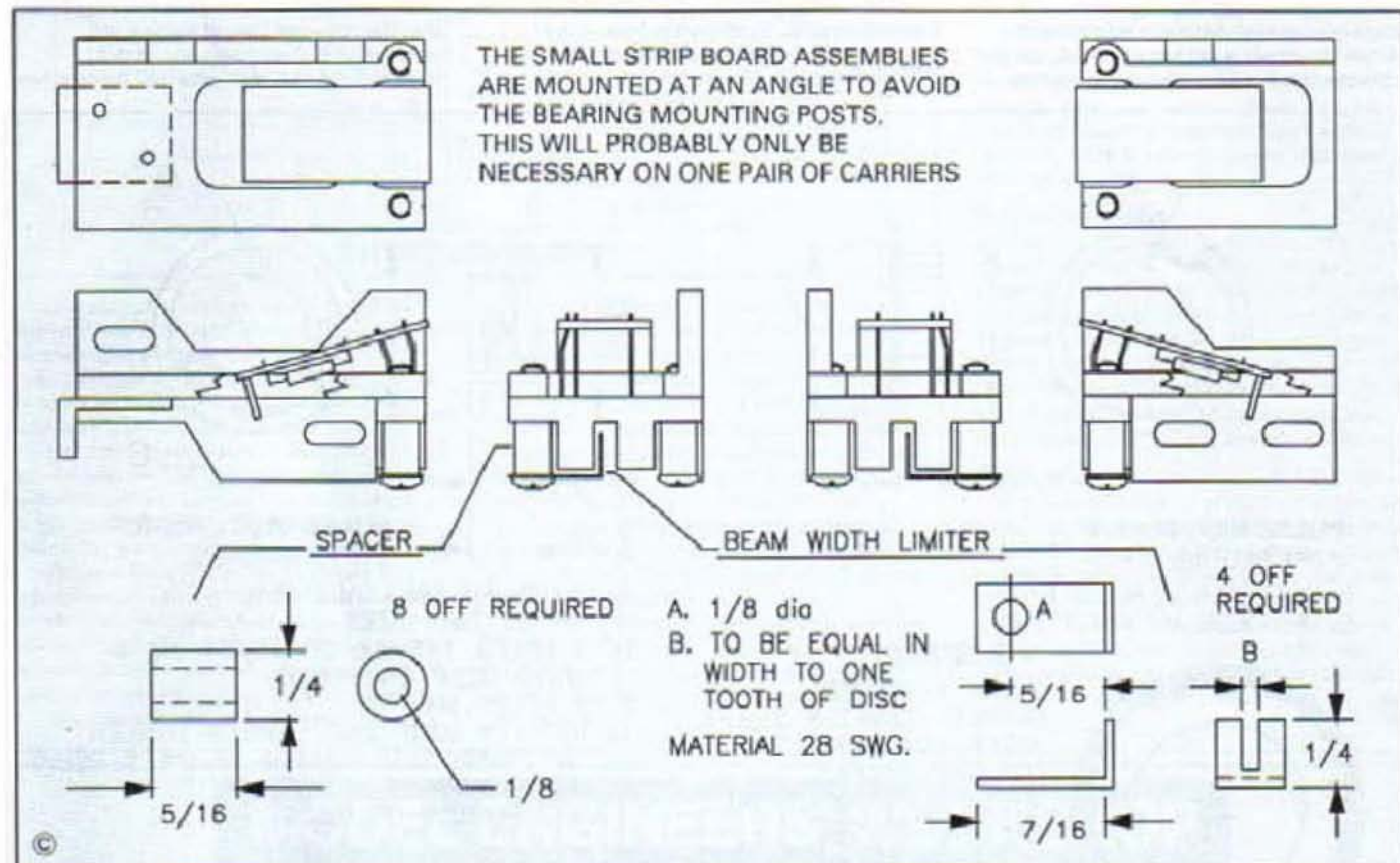
Engage the leadscrew and run into position and fix using the bearing fitting screws. Again test before commencing with other display.

This fitting procedure relies on there being sufficient length of plain section at the pulse unit end of the leadscrew. If this is not so then it may be necessary to return the screw to the lathe and remove a portion of thread to increase this length.

Position four of the foam washers, one on each post, and then place the lid over the leadscrew but not onto the posts. In any case, the leadscrew should be

there are no end thrust faces in the bearing at this end, it is only the pulse disc assembly preventing the bearing sliding backward and forwards. Care must be taken to ensure the disc does not become damaged.

Not done on the prototype, but probably worthwhile, would be to add two large holes, say $\frac{1}{2}$ inch, in suitable positions in the side or top of the box, using one to let



THE TABLE LEADSCREW

The table leadscrew is rather more difficult to fit in position. Remote the handwheel and bearing totally from the end the unit is to be fitted. Also remove the outer thrust ring at the other end. Now as the leadscrew is rotated in the correct direction it will feed through and project further at the end where the pulse unit is to be fitted. As a result, this will give more space to work.

extended sufficiently to prevent this due to the larger diameter screw thread.

Follow this by sliding on the pulse disc and box simultaneously, as in the previous case. Again fix a gasket of double adhesive to the bearing face and fit this onto the back of the box as before.

Refit the ring at the outer end of the bearing and follow this by positioning the pulse disc on the spindle, tightening this using the grub screws. Unfortunately, as

light in using a torch, and the other as an inspection hole to see that all is well.

The grub screws could also be approached through these if any final adjustment was considered desirable. These holes could eventually be closed using self-adhesive foil tape, as is also suggested later for protecting the upper join in the boxes against entry of any substance, such as cutting fluid.

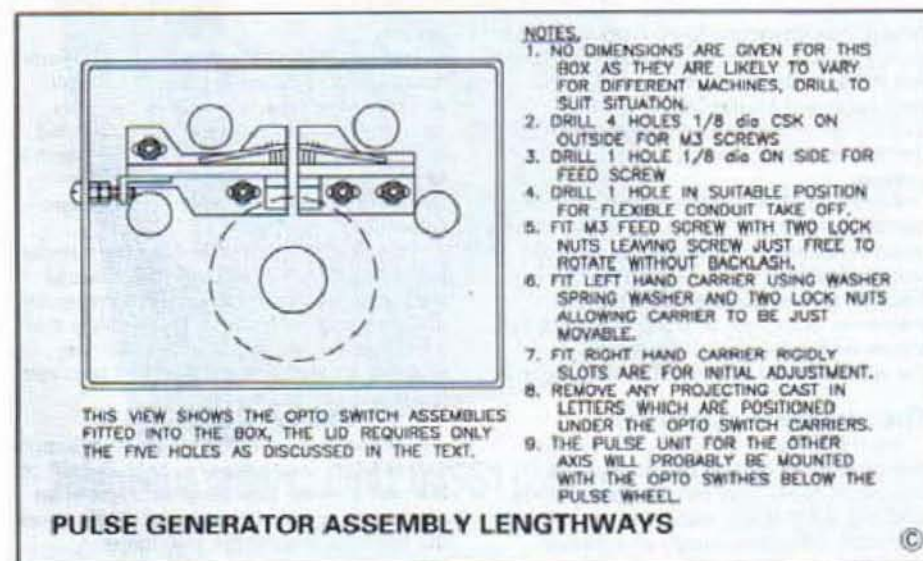
After a final inspection of the inside of the box, fit the lid and, with much care, wind the leadscrew back until the box slides over the posts and is into its final position.

With this done fit the bearing fixing screws and return to the other end of the table, refit the thrust collar and rotate the leadscrew. Either look if, if inspection holes have been added, or listen carefully if not, to be confident that the pulse disc is not fouling with the opto switches. Having done this the installation of the pulse generator units is complete. Connect to the display unit and test.

Positioning the display unit

The display unit should now be fitted in its final location and the flexible conduit and cables cut to their required lengths. Try to run the pulse unit cables in the flexible conduit as remote from any mains cables as is possible, particularly the machine drive motor cables.

Fit the conduit into the holes provided in



the display box and make off the cable ends as indicated in the installation diagram. Do ensure the screens are connected as indicated at this end; with this done, make a final test to see that all is still well.

This will be the first time the system has been tested as a whole unit and, without doubt, the pulse generator positions will require setting to achieve the required $\frac{1}{4}$ cycle displacement. This adjustment is quite critical and therefore adjustment should be made a little at a time. If, on arriving at a position where the counter

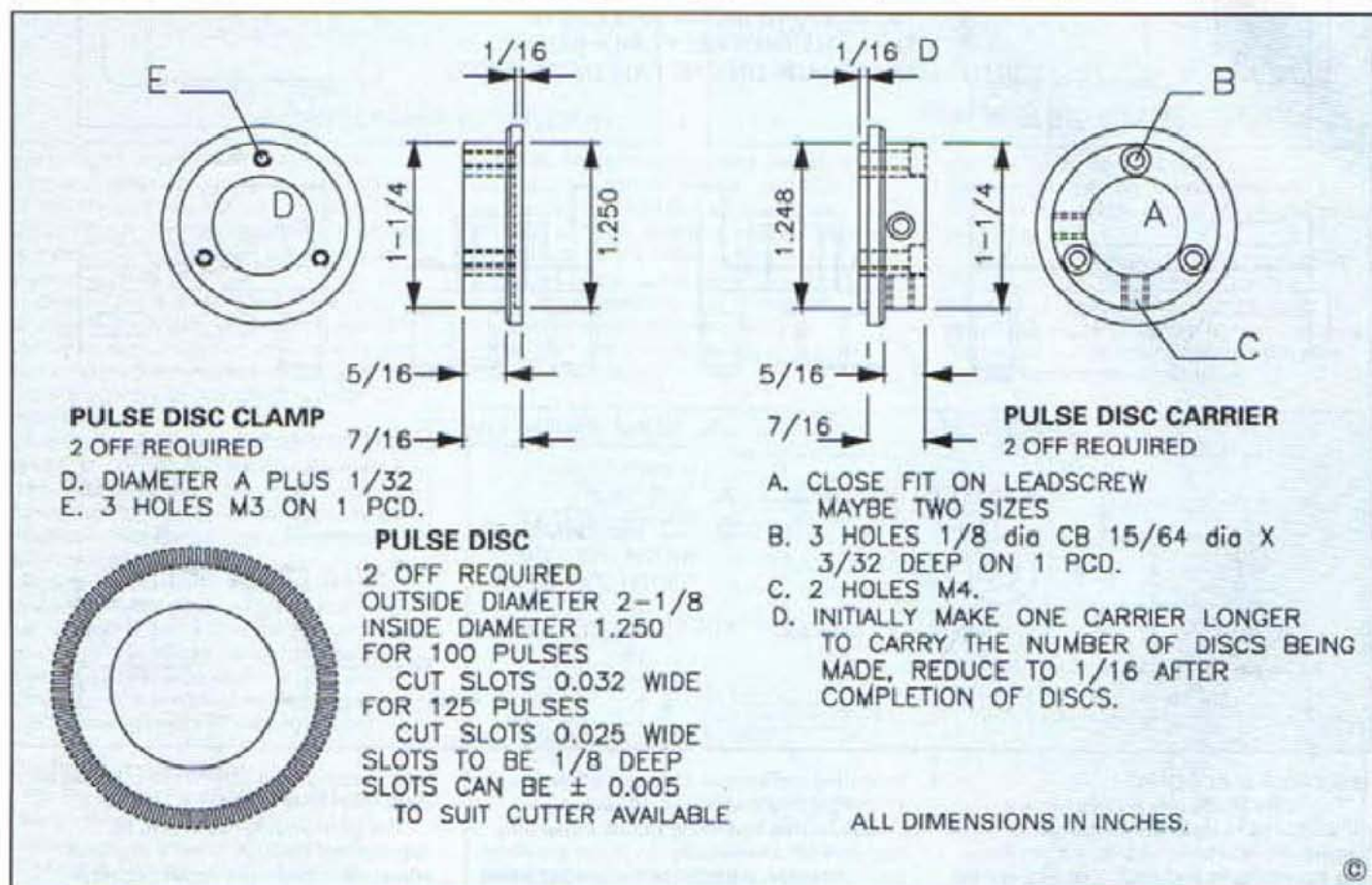
reason for, and method of overcoming this, has not been investigated. Anyway, because all readings must be taken in the same direction, and the leadscrew will be reversed again, the two errors will cancel themselves out.

The boxes as used have a reasonable degree of protection against the entry of contamination but are not moisture proof. To assist here, the top edge at least would benefit from the addition of a metal foil adhesive strip, as shown in one of the photographs. This would prevent cutting fluids finding their way into the assembly.

destination.

If a fault appears as the installation is being interconnected, first test that the power supply is available on all units being considered. Then test that the pulses are leaving their respective unit and arriving at their destination.

Typically, check that a pulse output is available at both opto switches and that they arrive at the A and B terminals on the pulse and direction shaping circuits. Then, that the required output signals are present, at the up/down and count terminals on this unit, and that these arrive



counts a full 100, or 125 per rev. but is counting in the wrong direction, continue to adjust the position in the same direction until the count reverses and then counts a full 100 or 125.

If insufficient movement is available, reverse to arrive at a satisfactory count at the other end. From this explanation you will gather that, as the pulse unit approaches its ultimate position, it will count but will miss some. This will be due to the slight errors in the pulse wheel.

One other feature which may have been noted in earlier tests but will, if not, certainly become evident now, is that when the leadscrew reverses, one further count will be made in the original direction. The

Retaining the technical information

One final suggestion. I hope this addition to your machine is destined for many years of beneficial use. Therefore it is not unreasonable to consider that at some time it may develop a fault. Now if at some time you find it regrettably necessary to thin out the bookshelf, and dispose of some back copies of *Model Engineers' Workshop*, you may find yourself without the diagrams for your digital display system.

Fault finding on electronic equipment can be a nightmare if the back-up technical documentation is not available, even for the most experienced electronic engineer. Because of this, do take copies of the diagrams, parts lists, and the suppliers data sheets and retain these in a safe place in the workshop for future reference.

The complete installation

Fault finding on the complete system should present little problem once the individual items have been established as working. All that will require to be tested is that each individual supply or signal is available and arrives at its correct

at the appropriate counter terminals.

With this procedure worked to, fault finding on the final installation should present no problem. There are, though, two more obscure conditions that may arise, one not really due to a fault on the system.

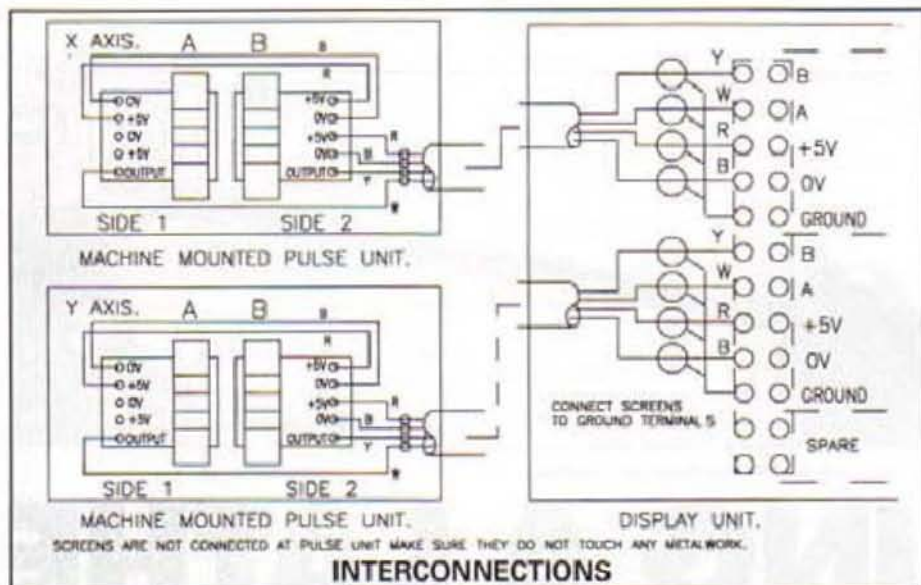
First, do make sure that the instructions with regard to earthing the zero volt rail and the screen leads are complied with exactly. If any earth connection, intended or otherwise, is made, the result of which is to create a loop, this loop can act as a transformer turn, and develop a voltage within it.

This results in some parts of the circuits being at a different voltage, even though they are interconnected on the same earth and zero volt rail circuits. The result is that a 5 volt pulse arriving at a unit will only look like a 2 volt pulse, if that unit zero volt rail is actually at 3 volts.

If this is suspected as a problem, disconnect the mains derived power supply and connect up a battery supply. Switch off the mains to the workshop, and test in an electrically noise free situation. If this cures the problem inspect the installation thoroughly.

QUICK TIP

Damaged kitchen worktops are frequently seen being sold at very low prices at the local DIY superstore. They make excellent bench tops for marking out and assembly work as they are very easy to keep clean and are also very rigid.



Probably the easiest way to consider how the earth circuits should be is like the branches of a tree, pruned so that no branches touch each other, and no branch is allowed to sag to touch the ground. In this way there are no loops.

The second situation is not due to a fault on the system but due to interference from external circumstances. This will appear as large jumps in the count displayed, even when the leadscrews are not rotating.

These will be due to large pulses of interference, caused by other items in the workshop being switched on and sometimes off, and getting into the counter assembly either via the mains leads or picked up on the interconnecting cabling.

The first test would be to see if they are

the result of airborne interference; this can be done by reverting to the batteries for a power supply. If the condition still exists, it is not being introduced via the mains.

This test is by way of confirmation of the fault being with mains supply as, providing the pulse connections have been kept away from the mains cabling, this type of fault is unlikely. If you have a Direct on Line starter, ie coil operated and not manually operated, and the conditions always occurs on switch off, it is likely to be due to pulses generated by this.

Ask your supplier of this starter to obtain for you from the manufacturers a coil surge suppressor unit; this will have two leads that require to be connected across the starter coil.

Should the condition occur on motor switch on, try to connect your display unit to a socket as far removed from the motor circuit as is possible. Do this even with an extension lead into the house as a test, though not obviously as a permanent solution. If the supply cable to your workshop is adequately rated this really should not be a problem. I have included it as, due to my omitting to fit a capacitor to the power supply, I *did* have the problem.

I found that whilst the display was fed from a socket on the same circuit on the motor, the fault was evident. This was OK though, if the supply came from a socket on a second circuit in the workshop and was even OK from the same socket, if connected via a short extension lead.

A final thought

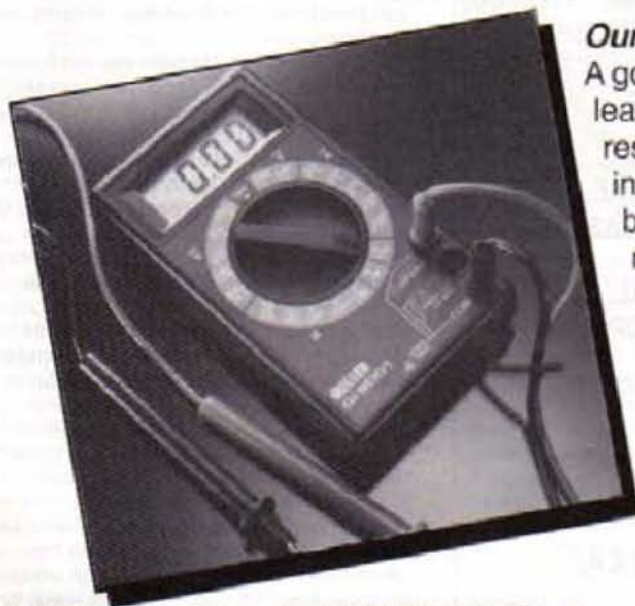
If you have now been adventurous enough to read this complete article you may have been put off considering making this device due to the many comments as to what can go wrong! I do hope this will not be the case as, with care in manufacture, problems should be minimal. But all the fault finding suggestions are here should you just require any of them ...

Postscript

It has been realised at this late stage that if the box on the table leadscrew were to be lowered it would make manufacture of this assembly easier. With the box lowered so that only the two lower posts passed through the box, it would then become very similar to the lower leadscrew assembly. The result may be visually less acceptable, but would considerably ease this problem.

MODEL ENGINEERS' WORKSHOP READER OFFER

DIGITAL MULTIMETER



Our offer this month is

A good-quality handheld digital multimeter complete with leads, the **Q19001** offers AC/DC voltage, DC current and resistance measurement. A diode test facility is also incorporated. This rugged unit offers accuracy ratings between 0.7 and 1.5 percent of reading. This excellent multimeter has a price tag of **£19.50 + £1.50 p&p**.

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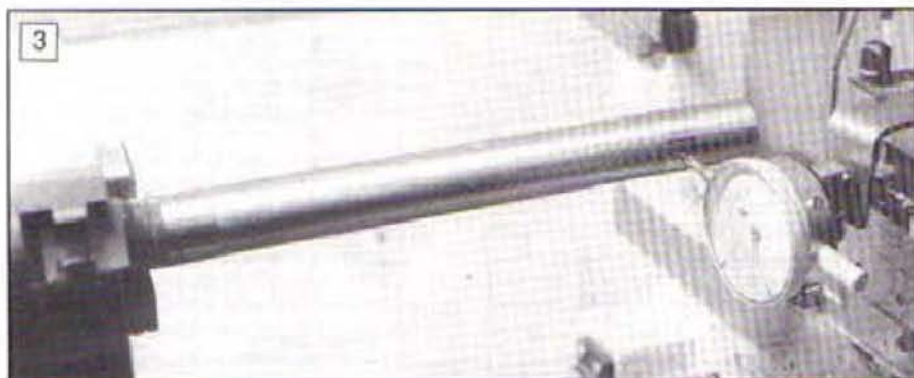
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Model Engineers' Workshop Reader Offer, Argus House, Boundary Way, Hemel Hempstead, Herts. HP2 7ST

I recently moved house to one with a larger garage, so that my workshop no longer has to fight for space with my car. Moving my mill/drill was relative child's play: I just had to dismantle it into pieces that I could lift more-or-less comfortably on my own.

The lathe, weighing in at 350 kg, more with its stand, was another matter, but as I had only about 1 km to move I hired a fork lift truck, waited until lunch time so that traffic police could be relied upon to be scarce, and then loaded lathe and its stand on to the forks, tied it on, drove to the new garage and deposited it in its new site.

If it were only that simple to get the machine tools going again! The lathe had



3: Test set up for "No Change" method.

ALIGNING A LATHE

Bill Morris from New Zealand moved home recently. Rebuilding his workshop led him to investigate the problems which can arise when installing machine tools in a new environment. In this article he shares some of the lessons that he learnt

Figure 1

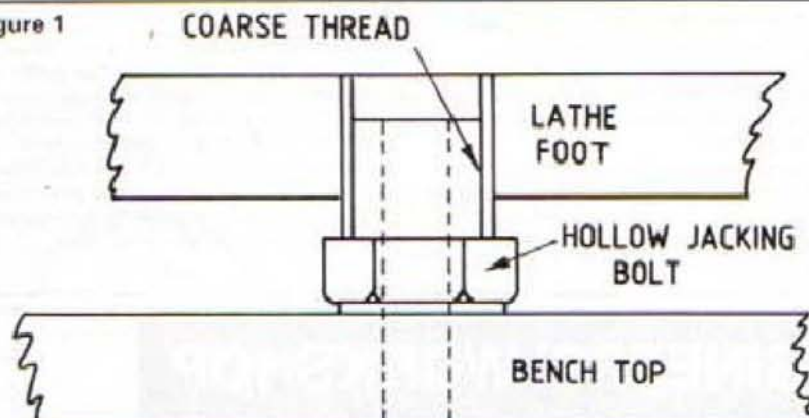
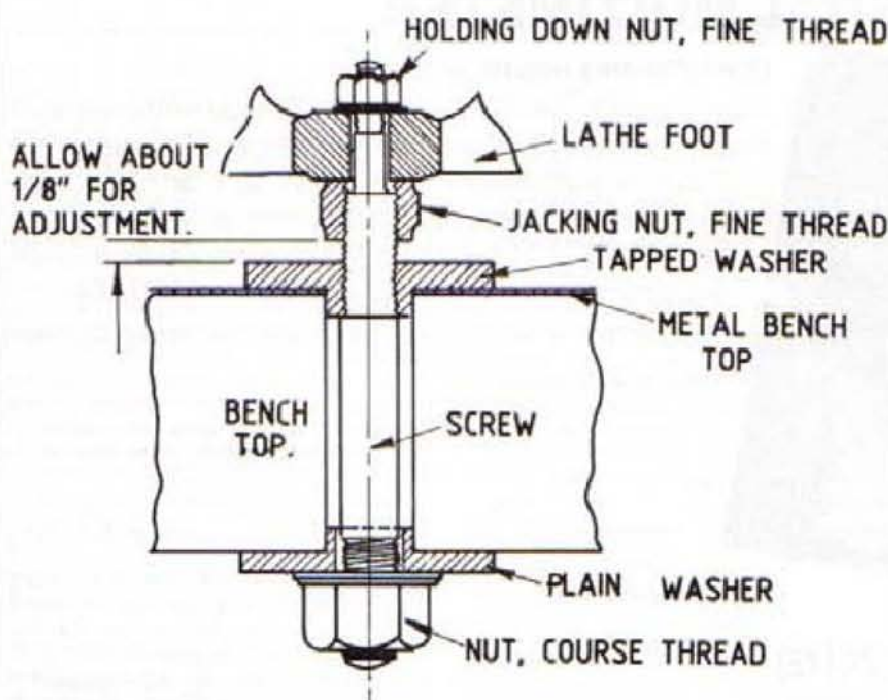


Figure 2



to be realigned, and the milling machine rebuilt, and aligned. In this article, I will explain how to align a lathe in its new home. There is a kind of sublime pleasure in having a lathe that turns parallel and faces flat, just as there is intense frustration when you want a parallel bore and end up with a tapered one. I used to harbour dark thoughts about Messrs Myford and Boxford in the past, but now realise that it was my own ignorance about stresses and strains, rather than their indolence, that accounted for the poor work I turned out. But first a bit of history to explain why it should be necessary to align your lathe.

A bit of history

Robert Hooke was a great ideas man, but didn't seem to have the ability to follow his ideas up. However, in 1678 he wrote "About two years since, I printed this theory in an anagram ... viz. *ceiiinosssttuu*, *id est, ut tensio sic vis*; that is, the power of any spring is in the same proportion with the tension whereof; ..." This has come down to us as Hooke's law, which can be applied in general to elastic materials, that is to say materials that go back to their original shape after deformation. The more you load them, the more they deform, up to a point.

Thomas Young, by contrast, did follow up his ideas but was not good at explaining them. At times he was almost impossibly obscure, as for instance in "... we may express the elasticity of any substance by the weight of a certain column of the same substance, which may be denominated the modulus of elasticity, and of which the weight is such that any addition to it would increase in the same proportion as the weight added would shorten, but its pressure, a portion of the substance of equal diameter." Happily, the modern form of this sentence says that the modulus is the ratio of the stressing force and the resulting strain or deformation. In effect it is a measure of stiffness and also implies that where there is stress there is strain.

Applying this to a lathe bed, a fly landing on the middle deforms it though perhaps not measurably, leaning lightly on the tailstock twists the bed a little and, often in a small lathe like a Myford or Boxford, to an easily measurable extent; and bolting it down incorrectly may deform it a lot when one considers that several tonnes of force can be applied by tightening quite a small nut.

Wood and loads

Many people know that the lathe deforms under load but give next to no thought about what they attach it to. Perhaps the logical place to begin is with the floor on which the lathe stand or bench is going to rest, as that too is going to deform under load transmitted to it via the bench. A timber floor in an upstairs room is perhaps the worst as it isn't usually possible to reinforce it without upsetting the people who want to use the room underneath and one must put up with it as it is.

Weight for weight, timber is about as stiff as steel and it has the advantage over steel that it creaks a lot before it fails, but unfortunately it creeps. This means that it deforms slowly, and usually irreversibly, under load. Wood also has a most irritating habit of changing its shape quite substantially with changes in humidity and temperature. It is made largely of cellulose (some would say 'swellulose' in this context) and can easily show an increase in dimensions across the grain of two percent. In very unfavourable circumstances, it can increase up to ten percent and, since no paint or varnish is totally impermeable to moisture, painting or varnishing the wood only partly solves the problem. Many amateurs will have their workshops in a wooden shed. Given the choice, I would prefer a concrete floor with a proper dampproof membrane to a wooden floor, though wooden floors seem to be easier on the feet. If you have to have a wooden floor and can get underneath it, it might be worthwhile to brace it beneath where the lathe is going to be.

From what I have written about the properties of wood above, it should be clear that it is a good idea to make every possible effort to have a metal bench or stand, and to make it as heavy and as stiff as you can manage. It doesn't have to look nice and can quite easily be built from scrap, as mine is, as long as its legs are strong and the whole structure is stiff. A really heavy wooden bench with 50 mm timber top won't deform much when you deposit your Myford or Bofford on it, but the lathe may deform the timber as you bolt it down, and your lathe can almost as easily be deformed by the timber as it changes shape with changing humidity. A metal top with timber legs is perhaps an acceptable compromise, as change in length along the grain with variation in humidity is negligible.

Most accounts of lathe alignment start by telling you to start by getting the lathe level, either by putting shims under the feet of the lathe or of the stand; or by using whatever ingenious arrangement the manufacturer has provided. The Bofford ME10 has a very easy-to-use arrangement (Figure 1). As well as being level along the bed and across the bed, it should not rock on its feet.

A lathe with three points of attachment instead of four seems very attractive because it would not rock and would not be greatly more difficult to level. However, it may be necessary to introduce strains to correct, for example, minor twisting of the bed along its length and you can't do it if the tailstock end is sitting on only one point. There is nothing very special about it being level except that it is an easy condition to set up and can make some setting up operations on the lathe easier. It

is sometimes suggested that as it was made on a machine that was level you should install it level, as gravity will otherwise introduce forces and strains that were not present at manufacture. This is theoretically correct but a moment's thought will show that; provided the out of level angle is small, such forces will be very small.

Stresses and strains

When the bed is cast, the outside cools first and applies compression to the inside metal. When this skin is removed during machining, stresses are released which deform the newly machined part. Years ago, the bed would have spent a few months doing nothing after rough machining and would then be finish machined after most of the stresses had been relieved by the passage of time. Nowadays, parts tend to be designed so that release of stresses by machining are minimised and they may also be heat treated to achieve the same result much more quickly. None of this may happen in a lathe being built down to a price that the amateur can afford, so that the bed may show deviations from the ideal shape. In any case various bits and pieces get attached to the bed after machining, all doing their little bit to twist and bend the

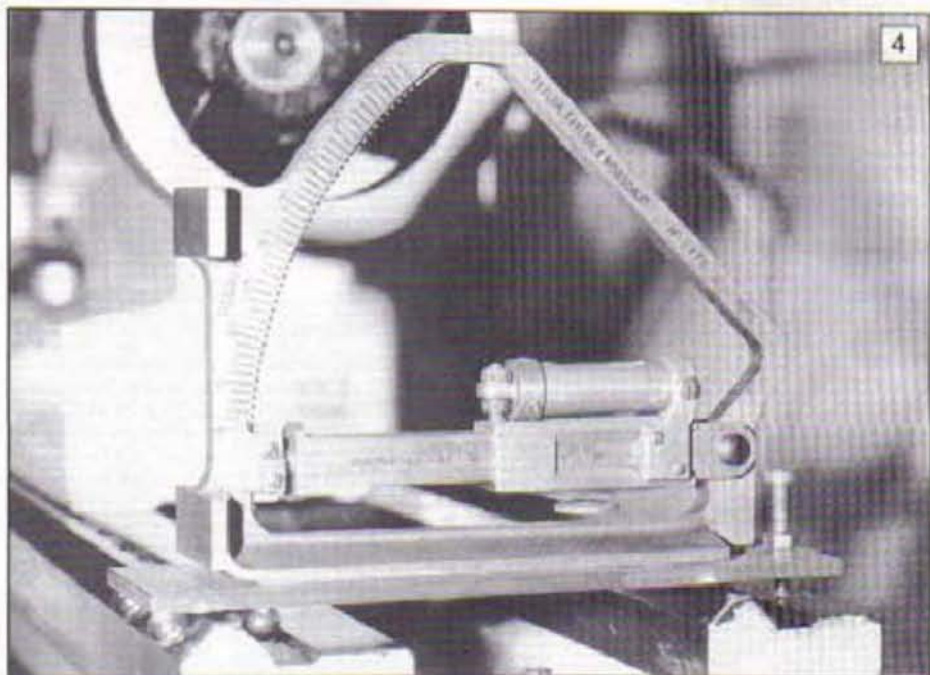
are, of course, much more elegant solutions, like the one suggested by Tubal Cain in a *M.E.* article in 1973 (Figure 2) or the use of raising blocks.

Making a start

For the amateur, the easiest method of alignment is then to put a piece of round bar of at least 25 mm diameter and about 250 mm long in the chuck. Attach a dial test indicator to the tool post with the business end at centre height bearing on the bar near its free end (Figure 3). One then simply tightens up the fixing bolts so that the initial reading on the DTI remains the same. In principle, the lathe has then been bolted down without changing whatever shape it had when it was standing free.

What the proponents of this method often forget, however, is that this shape may not be the ideal one that results in the lathe turning straight and facing flat, because of the heavy bits and pieces like headstocks and motors that get bolted on after the bed has been finish machined. It is best to regard this alignment method simply as a preliminary to a practical turning test, of which more later.

If you own or have access to a precision level, it is possible to get the bed straight and without twist within the limits imposed by the precision of the level. A carpenter's



4: Jig for cross level testing.

bed. The purpose of the various setting up methods is to apply forces to the bed to correct any such deviations in such a way that the lathe turns parallel and faces flat.

Having got your lathe approximately level both along and across the bed and free from rocking, either by using shims or the jacking screws provided, leave things overnight if your bench or floor are made of wood, to allow for the inevitable creep. If the bench top is made of wood, you will have to have some arrangement to stop the lathe sinking into the top when you bolt it down and to stop the bolt heads cutting into the underside of the bench. Use large pieces of something like 8 mm plate to make washers and if you can get some substantial scraps to put between the bench and the lathe they will help to spread the load over a larger area of wood. There

level is nowhere near sufficiently sensitive for this. One with a precision of 60 seconds per division is barely precise enough since one needs to detect differences as small as 10 seconds (about 0.04 mm per metre). Again, you start by getting the bed approximately level along and across the bed and free from rocking. You then aim to bolt down the lathe in such a way that the level reads the same across the bed at both ends (and, it is devoutly to be hoped, at all points in between or things are seriously amiss). It doesn't matter whether the bed is truly level as long as each end gives the same reading.

If you have a lathe with vees and flats, set up the level on the flats on strip parallels or, better still, make a little jig. The one shown in Figure 4 has four ball bearings soft-soldered into four countersinks in a

piece of reasonably flat steel to embrace the vee and a single adjustable screw to rest on the flat. Two ball bearings and a single screw would do for a flat bed lathe. Do not reverse the level end for end as you move from one end of the lathe to the other or, if using a jig, move it on the jig. Unless the level is in perfect adjustment you will otherwise get some very confusing results. Of course, a ball or the tip of the screw could rest in a depression in the surface, so slide the jig slightly to check that the reading does not change.



5: *Blue-Tack to the rescue!*

If you have a Boxford, South Bend or Atlas lathe where the carriage moves on two vees, you should not assume that the tops of the vees were machined at the same time as the sides, and it is wise to make up sort of jig that bears only on the sides of the vees.

The level shown in **Figure 4** is an inherited First World War artillery field clinometer which I fitted with a new vial of 45 seconds per division sensitivity. If you can't afford or borrow a sensitive level, you may be able to afford a vial which you can stick to the jig with Blue-Tack for the time being until you can make a proper job of it. It does work as a temporary solution (**Figure 5**).

In making the adjustments, it is easier to bolt down the head stock front and back and then to do the adjustments at the tailstock end. It helps to visualise or even to sketch the bed as a hollow rectangular box with a twist along its length as an aid to

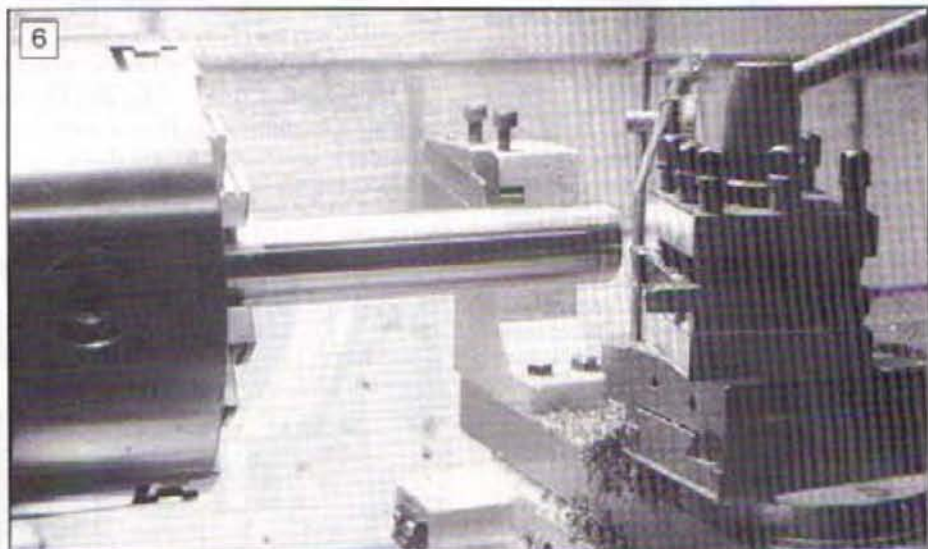
deciding whether to raise the front or the back. Each time you make an adjustment, tighten the holding down bolts hard and check by trying to rock it while looking at the bubble that doing so hasn't adjusted the bench rather than the lathe. Having got the reading the same across the bed at both ends, you can see whether it is the same all the way along the bed, taking readings both along and across the bed. This is quite a sensitive way of revealing out-of-flatness caused by manufacturing defects or wear.

Turning test

Having got the lathe adjusted by one or other of these methods, leave things to settle again if the bench or floor is of wood before moving on to the turning test. For this you put a piece of round bar in the chuck and face and centre drill the end. The diameter of the bar will depend on how

deflection is proportional only to the cube of the length.

With your chosen length projecting, about 150 mm of 38 mm bar for my lathe, support the end with the tail centre and rough turn two bobbins as shown in **Figure 6** with one as close to the chuck jaw as possible and the other as far away as possible. Having rough turned your bobbins, withdraw the tail centre and, using a very sharp and well-honed tool dead on centre height, take a fine cut over the bobbins using fine power feed or the smoothest hand feed you can manage. You then carefully measure the diameters of the two bobbins. You must have some means of comparing the diameters of the bobbins and, for most people, a micrometer is the easiest method. If they are both the same the lathe is turning parallel at that diameter. If they are not, you have some adjustments to make.

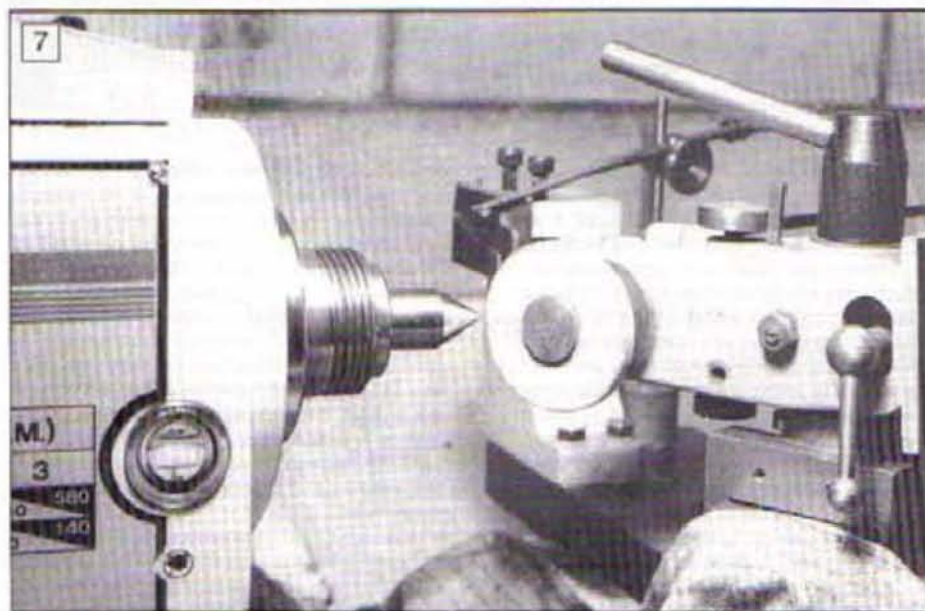


6: *Turning test.*

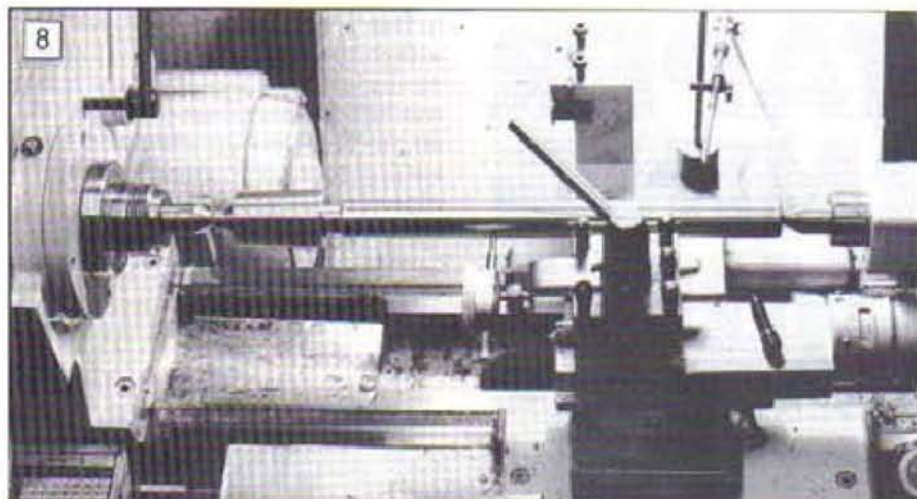
robust your lathe is. Since the deflection of a round bar loaded at the end is inversely proportional to the fourth power of the diameter, a 1 inch bar will deflect about five times more than 1/2 inch bar ($1.5^4 = 5.06$), so it pays to choose a bar as thick as you can easily machine. You can then leave more sticking out of the chuck and the sensitivity of the turning test will be enhanced as

If you have been able to set up the bed properly using a sensitive level and the bed is not significantly worn it will be obvious that, since the bed is not twisted or bent, the headstock must be out of alignment. For example, if the spindle nose is angled away from you, then the tool will take a shallower cut at the end of the bar than close to the chuck. Bearing in mind that even with a fine cut and a 38 mm diameter bar the work will spring away a little from the tool, you will get a larger diameter at the free end even when the headstock is in perfect alignment. If you aim for no difference, the spindle nose will be angled towards you a little, but at least you will be sure that the lathe will face only flat or concave, rather than convex. You really cannot do any better without a proper test bar that plugs into the spindle taper. By the way, incredible though it may seem to some, you can calculate that the 38 mm diameter bar shown in **Figure 6** droops 0.002 mm (0.00008 ins.) under its own weight alone.

Having established that the lathe turns parallel or as near as one can make it, you can use the same test bar to check on alignment of the centres by centring it at the other end and taking skims over the bobbins while turning it between centres. You then adjust the tailstock set-over until both bobbins are of the same diameter. You will of course thoroughly clean out the centre sockets in head and tail stock before doing this and stone off any scores on the



7: *Truing live centre using Quorn grinding head.*



8: Between centres test for alignment of centres.

taper shanks. It is quite a good idea to put a light mark on the soft centre opposite another one on the end of the spindle nose so that you always insert them in the same relative positions.

For high quality work, it pays to take a skim over the soft centre before turning between centres to make sure it is absolutely as concentric as the machine can turn. Not all 'soft' centres are soft and

instrument which you can use for realigning the tail stock after setting it over for taper turning. You set it between centres and run a DTI over the bobbins, adjusting set over until it gives a constant reading at each end. **Figure 8** shows a ground test bar set up for this purpose.

Final check

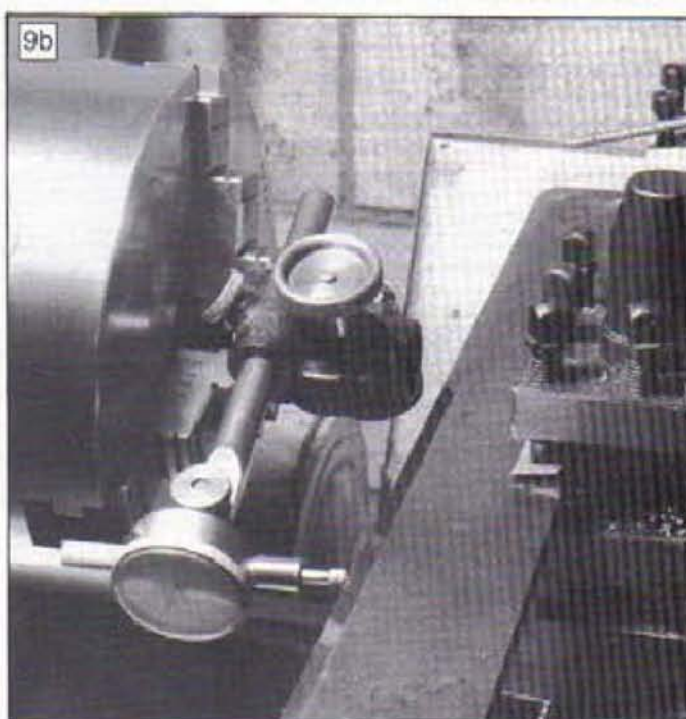
A final test is to check that the machine

QUICK TIP

35mm film cassettes are great for storing small items. They seal when closed and are good for holding ready-mixed fluxes or even a small quantity of washing-up liquid to add to the flux mix. A cassette tubful lasts for ages and having it in stock can save problems with the domestic authority when flux is being mixed.

not be square to the bed when clamped and there is not much you can do about that except recondition the saddle.

There is a geometric test you can do if you have a precision straight edge. Attach a DTI to the face plate with the plunger parallel to the lathe axis and pointing towards the tailstock. Clamp the straight edge horizontally in the tool post across the bed and adjust it until it is at right angles to the spindle axis by swinging the DTI through 180 degrees until the reading off the straight edge at each end is the same (**Figures 9a and 9b**). You then traverse the cross slide and if the reading remains constant, the slide's movement is at right angles to the lathe axis. If it is not, you may be able to tell whether it is due to wear in the bed and/or saddle by noting whether the changes are different depending on



9a and 9b: Turn around test to set straight edge square to lathe axis.

while a carbide tool can deal with these after a fashion, if you have a tool post grinder or a Quorn, this makes a better job of truing the centre (**Figure 7**). If the tailstock is out of line, it helps to have a DTI fixed to the bed with its plunger bearing on the upper part of the tailstock, so that your correcting movements can be less haphazard. Again, it is a matter of making small adjustments to the set-over until both bobbins are of the same diameter.

It is a good idea to wrap up the test bar you have used and put it somewhere safe so that you are not tempted to cut bits off it when you really cannot find anything else in that diameter. The scrap box is definitely not the place for this most useful

faces flat or concave. It must not face convex and a good quality lathe should depart from flatness by no more than 0.02 mm in 300 mm (0.0008 in./12 in.). For the amateur, a turning test by taking a facing cut across a workpiece held in the chuck and comparing the result with your best straight edge is probably the easiest. You can check that the lathe is not facing convex by holding the workpiece and straight edge up to a bright light. If it is both concave and holds a cigarette paper (coincidentally about 0.0008 in. thick) in the centre, things are near enough. If it does not face to your satisfaction, bear in mind that it may not be because the headstock is misaligned; the cross slide movement may

whether you wind the saddle towards or away from the headstock to zero the DTI.

It is well worth the time taken to set up a machine tool properly, to take full advantage of the accuracy that is built into the machine. From what I have said, you should be in no doubt that where there is stress there is strain and will never again lean on the lathe or its stand when taking cuts. If your workshop has a concrete floor, you may even be tempted to run grout under your lathe stand so that things never move again. Perhaps you failed to notice that tiny movement of the level's bubble as you shifted your weight to ease your aching legs. Yes, even concrete floors deform under stress ...

A TAPER TURNING ATTACHMENT

FOR THE MYFORD 7 SERIES LATHES

In this article we have a taper attachment for the Myford series seven lathes. It incorporates a method for precision setting the angle. This permits the rapid setting to a given angle for any repeat requirements, such as Morse tapers.

There are three main methods for turning tapers on a normal centre lathe, each with its own advantages, and disadvantages. It is probable though, that many will have only used the method of setting the top slide to the angle required.

A method also available as standard on many lathes, is that of turning between centres, but with the tailstock centre set either forward, or to the rear of centre, to produce the required taper.

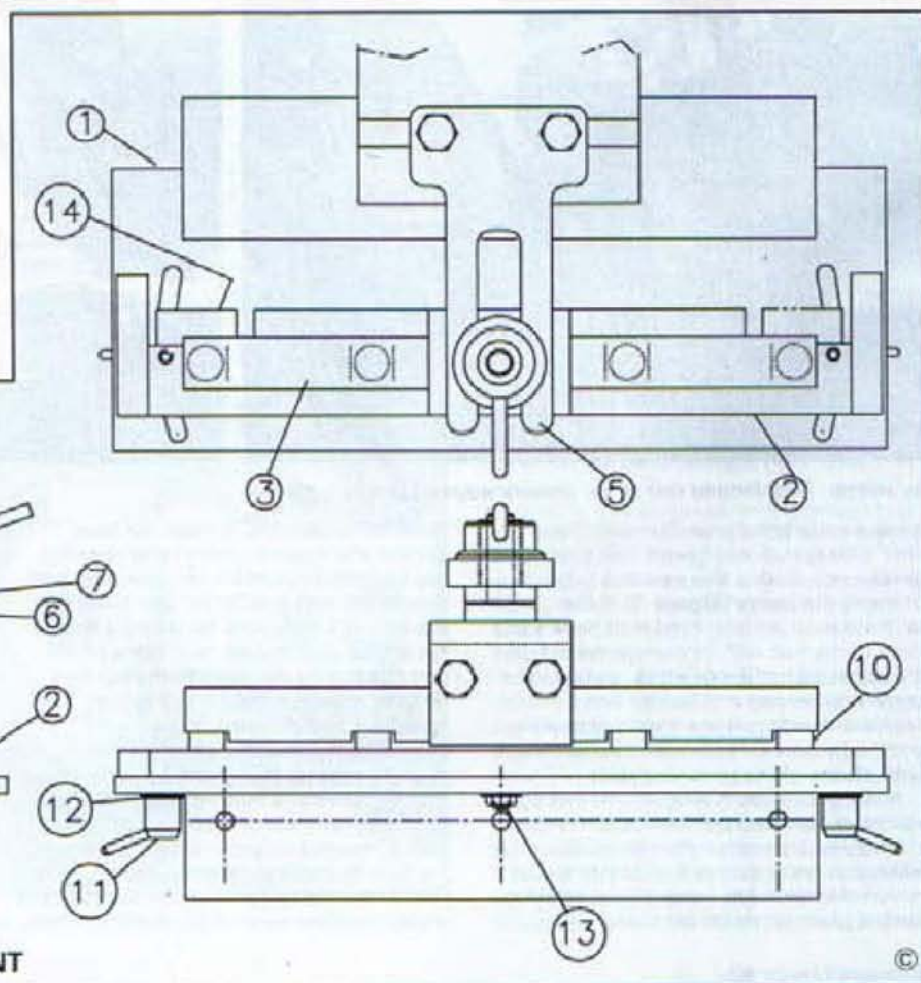
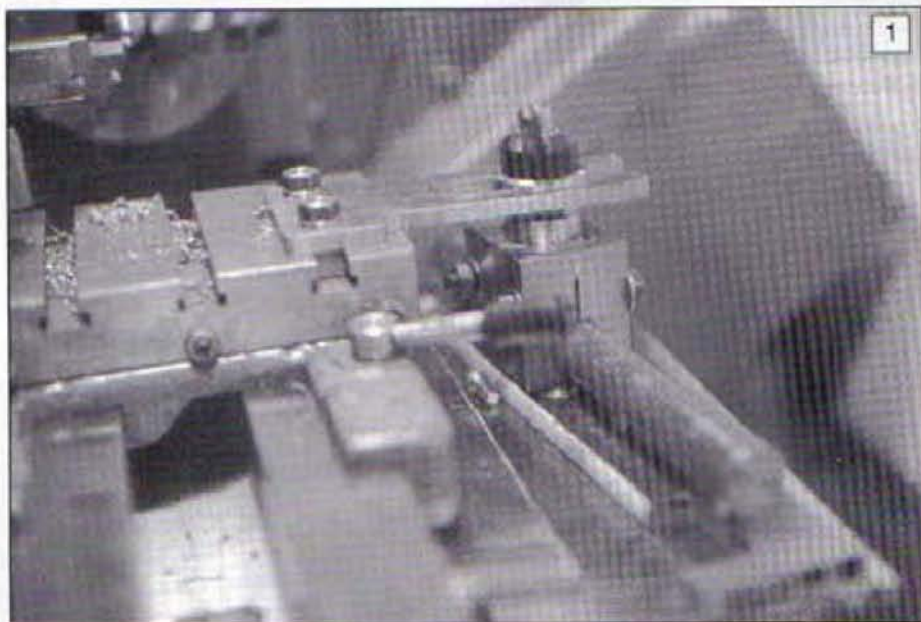
The third method, being that of using a taper turning attachment, which has to be purchased as an additional item, to the machine's basic equipment.

Topslide method

This method has much in its favour, it covers a wide range of tapers, and on many lathes can be set a full 90 degrees, to be parallel with the cross slide.

It is also normally calibrated, so that it is possible to get close enough to the required angle, for many requirements, without the need for further checking and adjustment. A minor disadvantage, is that after use, a small length of material will have to be turned as a test piece, to ensure that the topline is returned correctly for parallel turning.

By far the greatest disadvantage is the limited travel. This makes it difficult (but not impossible) to turn longer tapers. Typical of this requirements, would be a Morse taper, but by taking two sets of cuts, and with care taken of the transition between these, then longer tapers can be achieved reasonably satisfactorily.



GENERAL ARRANGEMENT

Taper turning from the tailstock

Using the tailstock, consists of either moving the tailstock towards the front, using the adjustment provided, or alternatively towards the rear. The result being that when turning an item between centres, a taper is obtained.

The major advantage of this method, is that it is the only practicable method for creating very long tapers using the machine's standard equipment, but then only with angles of a fraction of a degree, to a degree or two. In view of the angle being dependent, on the length of the item being turned, it cannot be calibrated.

Probably the best method for setting the tailstock is to calculate the offset required, and to make this using a dial test indicator. Even so, as the effective distance between the centres, will be difficult to know precisely, the method is not precise and trial cuts will be needed for precise results.

As the centres are now offset, the work will not seat perfectly on the centres, and some uneven wear could result if used frequently, though this should not be a problem for occasional use.

This method when used, requires the tailstock to be returned to a position, to achieve a parallel result. This is a time consuming operation, though when having achieved this, the test piece should be retained for use next time the process is used. A tool for offsetting the tailstock centre without shifting the body has been developed by Jabus Engineering Ltd, Ash Barn, Brounton, N. Devon EX33 2EG. Available with 1, 2 or 3 M.T. shanks, it can be obtained from Messrs Chronos or M.E.S.A.S.

On subsequent occasions, the test piece can first be used with a dial test indicator, to reset the tailstock, followed by a light cut to confirm the setting.

Taper attachment

This is without doubt the best method for producing medium length tapers, and up to about 20 degrees internal angle. Other than this limit to the angle it can achieve, its only other disadvantage is its high cost, for what is likely to be only limited use.

The design

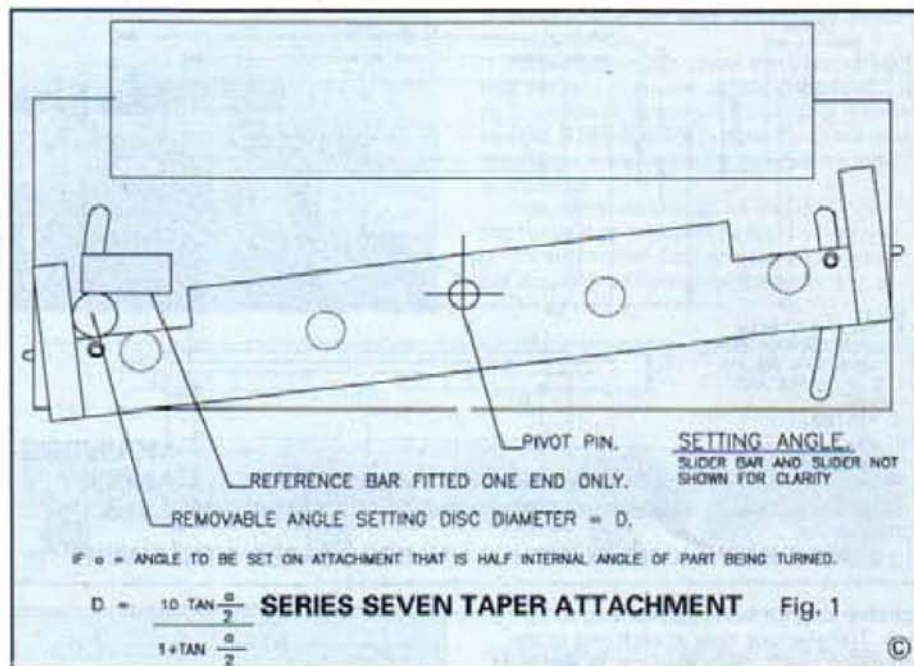
The design for this attachment follows fairly conventional lines, but possibly contains two aspects, that differ from the usual arrangement.

The first, being the use of a round bar, for the guide, as opposed to the more normal dovetail slideways, this will be easier for those without milling facilities.

The second, being the inclusion of reference faces. These, with a disc turned to a calculated diameter, can then be used to precisely set the angle to that required. This can be seen in Fig. 1.

As the guide bar pivots in the middle, it is necessary to have removable reference bars at each end, and only fit the appropriate one, depending on the angle required. To avoid errors due to them being removable, the reference bars have to have included, close fitting dowel pins. These locate them accurately, the screw only being used to retain it.

The formula for calculating the diameter of the disc, is as follows. For those who are interested in how it is arrived at, see the detailed explanation at the end of the article.



$$\text{Diameter} = \frac{2 \times L \times \tan \frac{\alpha}{2}}{1 + \tan \frac{\alpha}{2}}$$

where, α = the angle to which the attachment is to be set, being half the internal angle of the component being made.

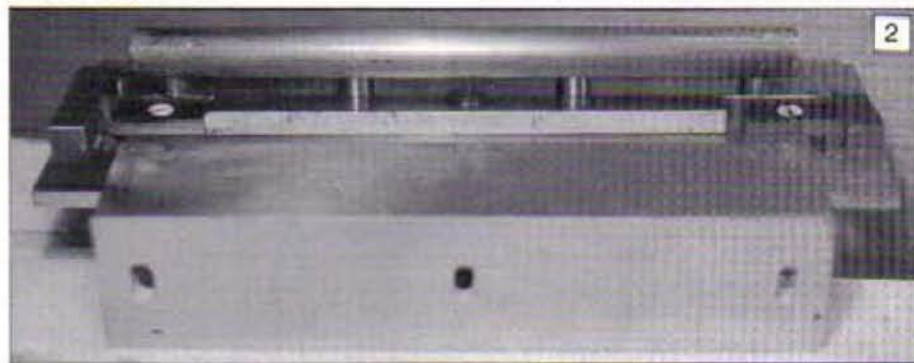
and L = the length between the pivot point and the reference faces fixed to each end of the pivoted bar.

Manufacture

Mounting angle "1" (Photo 3)

First cut the angle for mounting the attachment to the rear of the lathe and mark out very accurately the position for the mounting holes. These are best kept to a minimum clearance on the mounting screws, the centre hole could be larger if required.

The design has been arranged to permit some error in the vertical direction. Even so



The pivot pin has included a parallel extension, this to enable dimension L to be measured with a vernier, or other means.

The design indicates a length of 5 in. for this, simplifying the top line of the formula to $10 \times \tan \frac{\alpha}{2}$. If on completion, the dimension measures to some other value, this can be included for L in the formula. Alternatively the actual dimension can be adjusted by the addition of shims, or the end of the bar reduced in length, as appropriate.

The design covers a range of $\pm 10^\circ$ and those that wish could easily calibrate one of the end reference bars, calculating the diameters of the required discs for say 2, 4, 6 and 10 deg. to arrive at each position.

To minimise the requirement for accurate manufacture, the drive between the cross slide and the slider mounted on the angled bar is via a vertical pin. This locates in a close fitting bearing, mounted on the cross slide bracket.

By this arrangement, variations in the height of the bar relative to the cross slide can be tolerated, thus avoiding undue strain on the mechanism.

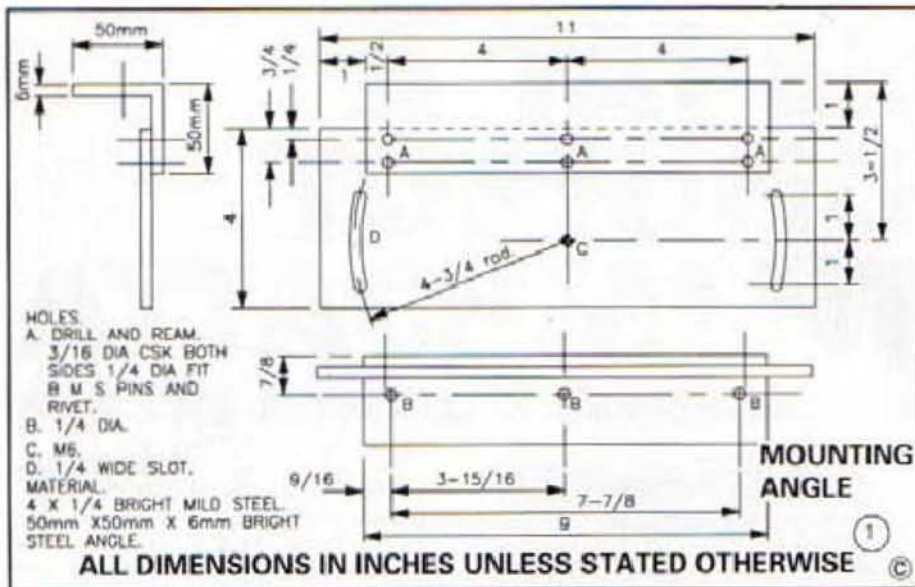
this is no reason for not attempting to set the top of the angle exactly parallel to the top surface of the bed. So do take care not only with the centres of the holes, but also with the distance from the top face of the angle.

(This is our first attempt at creating a design, writing the text, and then having the article test made by another. In this case the maker of the article has chosen to use slots, as can be seen in the photographs, and appears happy with the operation. Ed.)

Now cut the main plate, drill and tap the hole for the pivot pin. Follow this by making the curved slots for the clamping screws; these are in no way used to locate the bar and can therefore be a generous clearance on the clamp screws. Drilling a series of holes and then filing to create the curved slot should be quite acceptable.

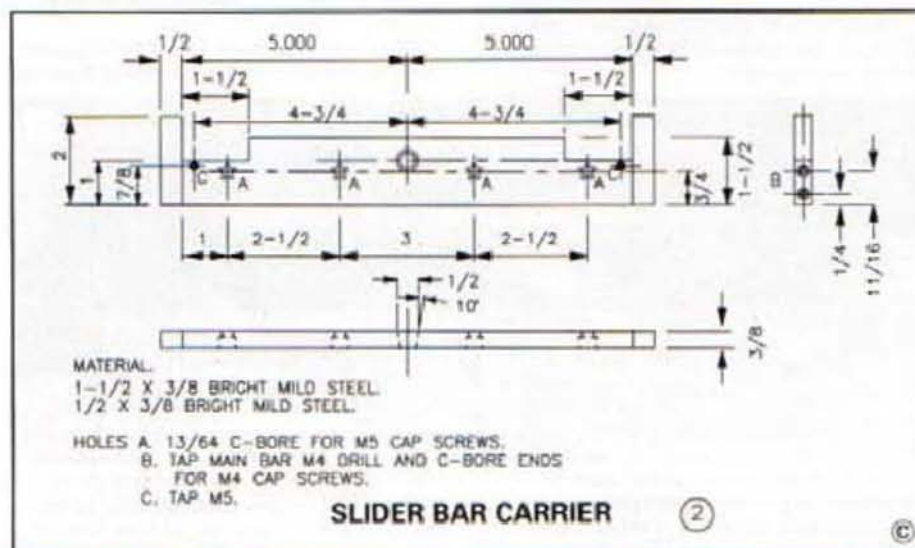
Drilling for the two small reference bars is left till later. These require to be set in position, when the unit has been set to turn parallel.

Follow this by drilling and counter-sinking for the rivet holes, use a drill of a



suitable size, for eventual reaming to $\frac{3}{16}$ inch. Transfer one hole at each end to the mounting angle, ream through, fit and rivet two pins with this done drill, ream and fit the remaining rivets. This completes the mounting angle.

The purpose of using reamed holes is to ensure the pins are close fitting. This will avoid any possibility of one part moving on the other if roughly handled, the result of which would be to upset the calibration.



Slider bar carrier "2" (Photo 4)

This comprises the base, with the reference arms fitted at the ends. Before proceeding with machining the base, do check to see that the material chosen is reasonably flat. If not another piece, if available, could be checked and if no improvement is found some approach to improve the situation will be necessary.

The pivot hole is tapered and the only realistic way of producing this is in the lathe, with the bar mounted on the faceplate and turned.

At 10 in. long and it needs to be a little longer than this for final machining, say plus 50 thou, it may be found impossible to clear the gap at this dimension.

As an alternative the bar can be drilled or bored on the milling machine or lathe vertical slide with a suitable large parallel bore.

A bush can then be turned on the lathe

to fit the hole, and with the appropriate tapered bore. This can then be fitted using resin adhesive, or even by lightly riveting (Photo 5).

Whilst working on the lathe and with the top slide set at the required angle, turn the pivot pin (Photo 6). Take note of the short parallel extension, this must be concentric with the taper, as it is required to assist in

measuring the distance from the pivot to the outer end.

Fit the pivot pin into the slider bar carrier and with a depth micrometer or other convenient method, measure the distance from the edge of the bar to the 0.500 in. dia. portion of the pivot pin. Add 0.250 in. to this dimension and this will be the distance from the edge of the bar to the centre of the pin.

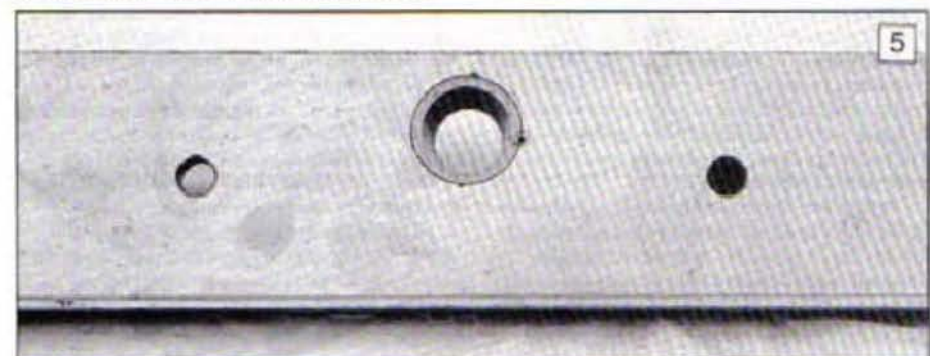
This dimension can then be used as the value for the depth of the portion to be removed from the ends of the bar. This can be done by milling on the milling machine or the lathe or even, with care, can be sawn and filed.

The requirement for accuracy of this face is not so great as would be anticipated. The face must be flat so that it eventually mates closely with the reference bar (14). But a few thou. error in position will have negligible effect on the angle arrived at, as the reference bar is eventually positioned to suit.

With this completed, drill the bar for the slider bar fixings, counterboring the rear, for the heads of the cap screws. Drill and tap the ends for fixing the end pieces.

Now make and fit the two end pieces. With this done and the pivot pin fitted, clamp a small piece of flat material to the inner face of the end pieces. Position this with it projecting above the bar surface, measure the distance between this and the pivot pin using a vernier.

Determine how much this is in excess of 5.250 in. (that is 5 in. plus half the pin diameter). Measure both ends and remove the required amount from each end to achieve the 5.000 in. dimension.



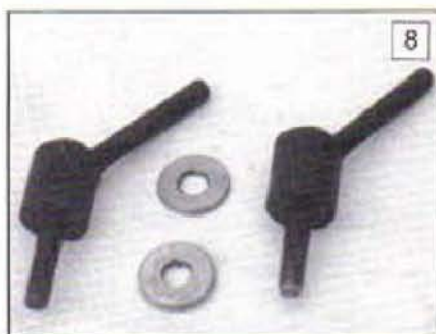


Slider bar "3" (Photos 7 & 8)

Locate a piece of straight $\frac{3}{4}$ in. dia. bright mild steel, cut to length and finish the ends. A fixed steady will be required to complete this on the lathe, otherwise a sawn and filed end will suffice.

Make the four flats for the stand off spacers, ensuring that each is cut to the same depth. It is essential that when this is bolted to the carrier neither become distorted. Ensuring that the flats are to the same depth should help to prevent this, providing the spacers are also all the same length.

Drill and tap for the four fixing screws, noting these are blind holes. For added precision, the bar could be made longer initially, to enable it to be held in the lathe chuck and a lap made and used to size the outer diameter. Best would be to use ground bar, not available from all suppliers of mild steel, but is listed in the catalogue from G.L.R. Distributors Ltd, Hertford, tel. 0992 552962. Make the four spacers (10) and assemble the complete slider bar unit, if it is found that some error exists, the length of individual spacer can be varied.



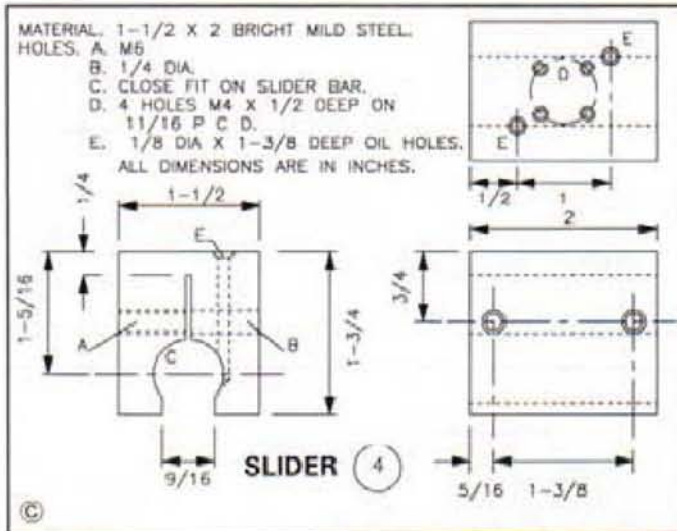
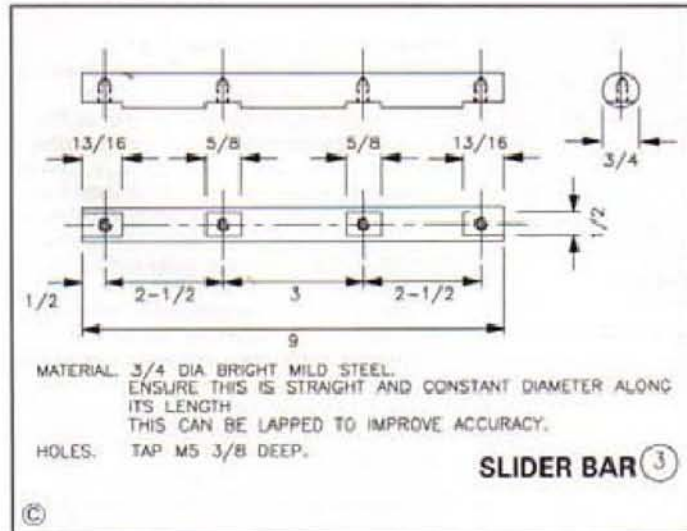
offset to enable the bore to be made in the correct position.

Before starting to create the bore, check that the face intended to be the top is at right angles to the chuck face, using a small square. If not, slightly loosen the chuck and reposition the part until a satisfactory result is obtained.

Also, the bore should be a close fit on the bar, but as adjustment is provided this is not that critical. Drill and tap all holes as per drawing and produce the $\frac{1}{16}$ in. gap at

the bottom, this is only clearance for the $\frac{1}{16}$ in. spacers.

The four holes on the top could be left and transferred from the drive pin. This would be easier and would ensure they line up. Most people will not have a large enough slitting saw to create the slot, so it will require to be made either with a hack saw or a band saw. If you are concerned about appearance, then making say a $\frac{1}{8}$ in. wide slot, with an end mill at each end, about $\frac{1}{8}$ in. deep, will camouflage the irregular result probable with a sawn slot.



Adjustment locking screws "11" (Photo 9)

Make the two adjustment lock screws, but without the short arm. Fit and tighten the screws then mark the position for the arms, that is, pointing to the side. Remove, drill and fit the two arms, in positions established. This makes sure that the arms are in an easily accessible position for tightening. Make also the washers (12) which are to be used with these clamp screws.

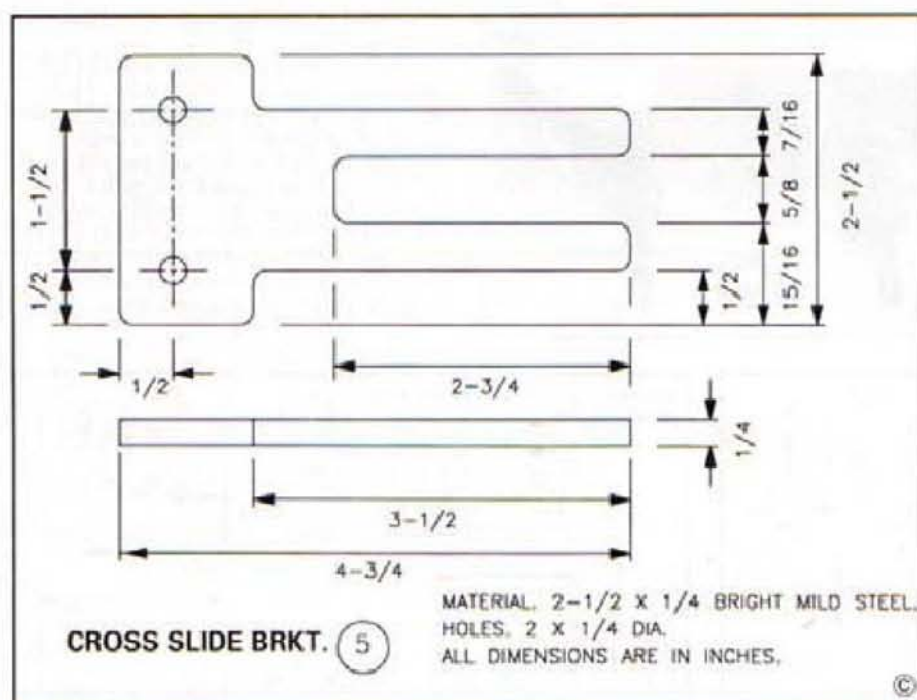
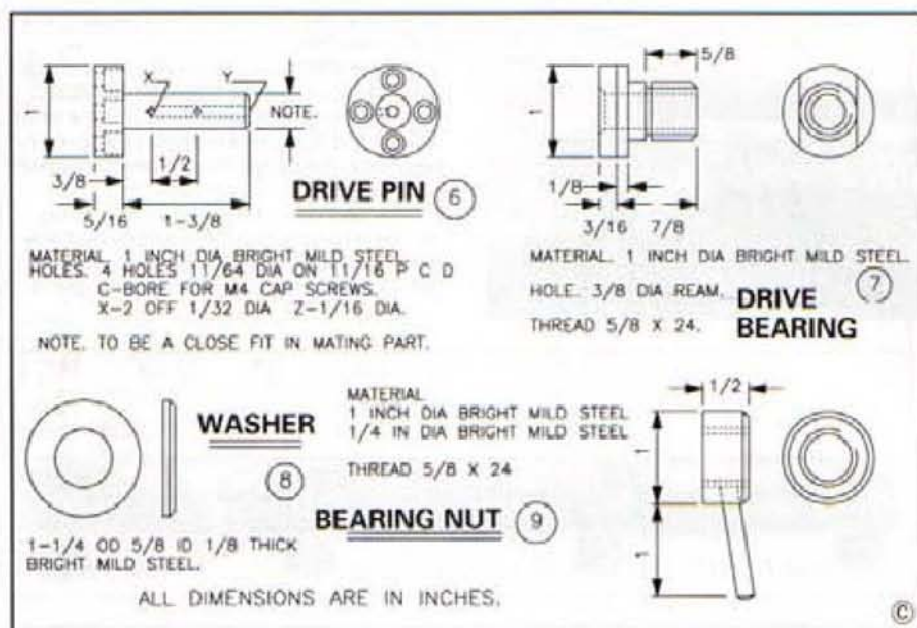
Slider "4" (Photo 10)

The only critical part of the slider is that the bore should run parallel to the top face. Place the material in the four jaw chuck.



Drive pin assembly "6 to 9" (Photos 10 & 11)

This consists largely of turned work and should present no real problem. Do ensure that the drive pin is a very close fit in the drive bearing, even to the point of being a little tight, otherwise all is straightforward.



The drive bearing (7) has a 5/8 in. x 24 TPI thread; this will require to be cut on the lathe. Note also the 1/2 in. wide flats, these to locate into the top slide bracket, to prevent it turning when being tightened.

The drive pin (6) has an oil hole included down the centre of the drive pin and two out to the side, these to provide an oil supply to the drive bearing.

Top slide bracket "5" (Photo 12)

The top slide bracket requires no explanation: the reduction in width is for appearance only and can be omitted to reduce the work involved if so desired.

Reference bars and set-up "14"

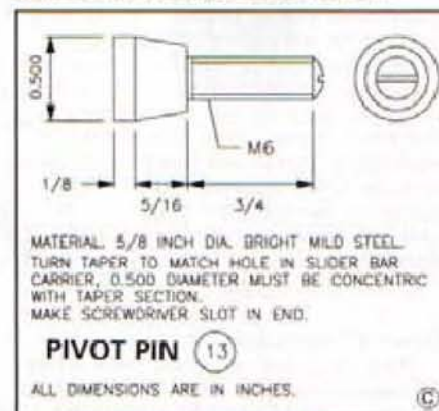
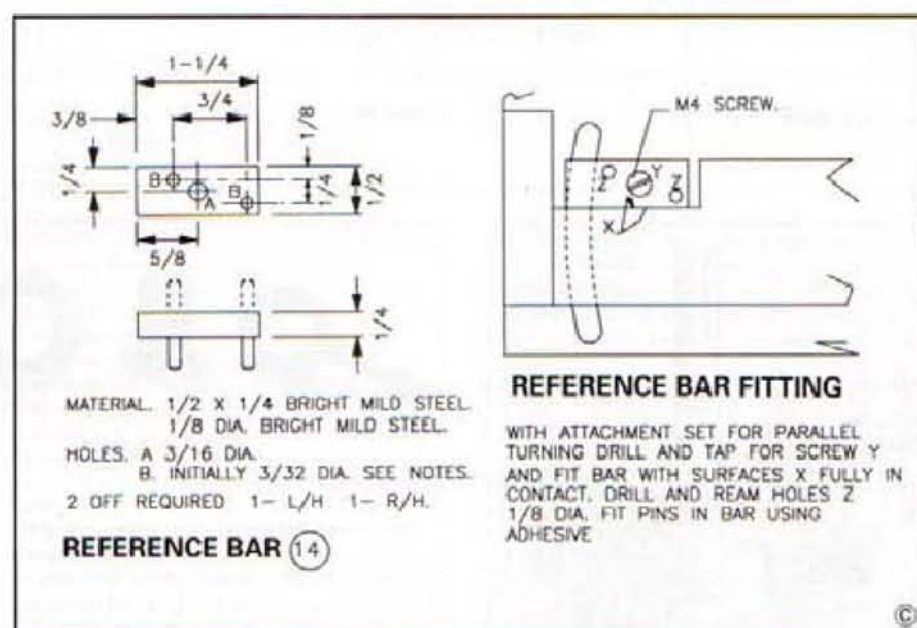
Make the two reference bars to drawing and place to one side. Assemble the otherwise complete attachment onto the lathe and estimate the setting for parallel turning.

Turn a bar over a length of at least 5 in., and measure to test it for being parallel. Adjust as required and again turn over its length; Continue this process until a satisfactory result is achieved.

With a parallel bar achieved, make sure that the adjustment clamp screws are firmly tightened, then remove the complete assembly from the lathe.

Place the small bars in position, as shown on the drawing and clamp to the slider bar carrier. Mark through the fixing hole, drill and tap the base as required.

Now using this fixing, fix the bars in place with the appropriate surface fully in contact with the slider bar carrier. Drill



through and ream the two holes in each, $\frac{1}{16}$ in. diameter. Do this whilst the parts are still fixed together.

Make four $\frac{1}{16}$ in. dia. pins, $\frac{1}{8}$ in. long, make sure these are a close but free fit in the lower holes. Fit pins into the small plate, using a little adhesive. This arrangement will ensure that these parts are always returned to precisely the same position each time.

In use, only one of these two reference pieces is fitted and a disc turned to the calculated diameter and used as indicated in the drawings. The disc can easily be turned, using a washer mounted on a screw, with the screw fixed in the three jaw chuck.

If so desired, this method can now be adopted to calibrate the assembly in degrees for approximate setting requirements.

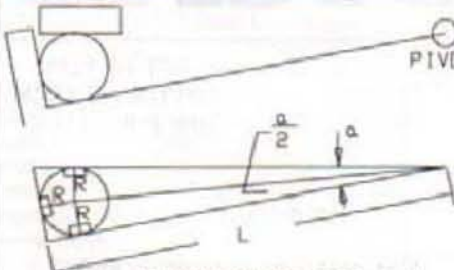
For those who are not at home with the mathematics, but would still like to calibrate the assembly by this method the following list details the diameters required for whole degrees.

When made, these can be used to calibrate the attachment. They could then be retained to accurately set the angle to whole degrees as required on other occasions. This is worthwhile, as this method will be much more accurate than setting to a scale marked on the attachment.

Degrees	Diameter
1	0.086
2	0.172
3	0.255
4	0.337
5	0.419
6	0.498
7	0.577
8	0.653
9	0.730
10	0.805

The mathematical principle

For those who like to understand the mathematics which result in the formula given for the diameter of the setting disc, the following diagram shows how this is arrived at:



DIAMETER OF DISC = D

$$R = \frac{D}{2}$$

TAN ANGLE = $\frac{\text{OPPOSITE}}{\text{ADJACENT}}$

$$\tan \frac{a}{2} = \frac{R}{L - R}$$

$$\tan \frac{a}{2} \times (L - R) = R$$

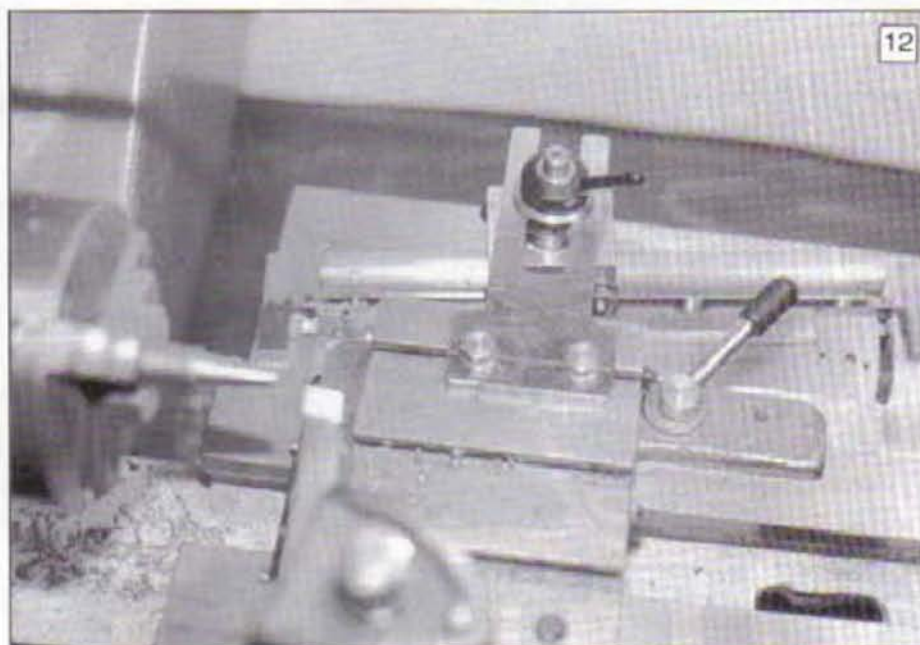
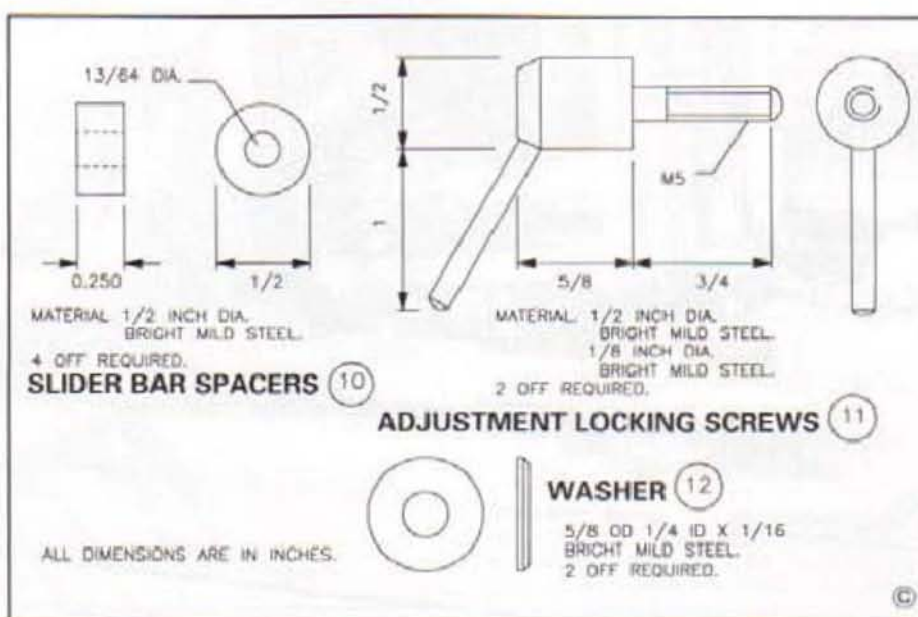
$$L \cdot \tan \frac{a}{2} - R \cdot \tan \frac{a}{2} = R$$

$$L \cdot \tan \frac{a}{2} = R + R \cdot \tan \frac{a}{2}$$

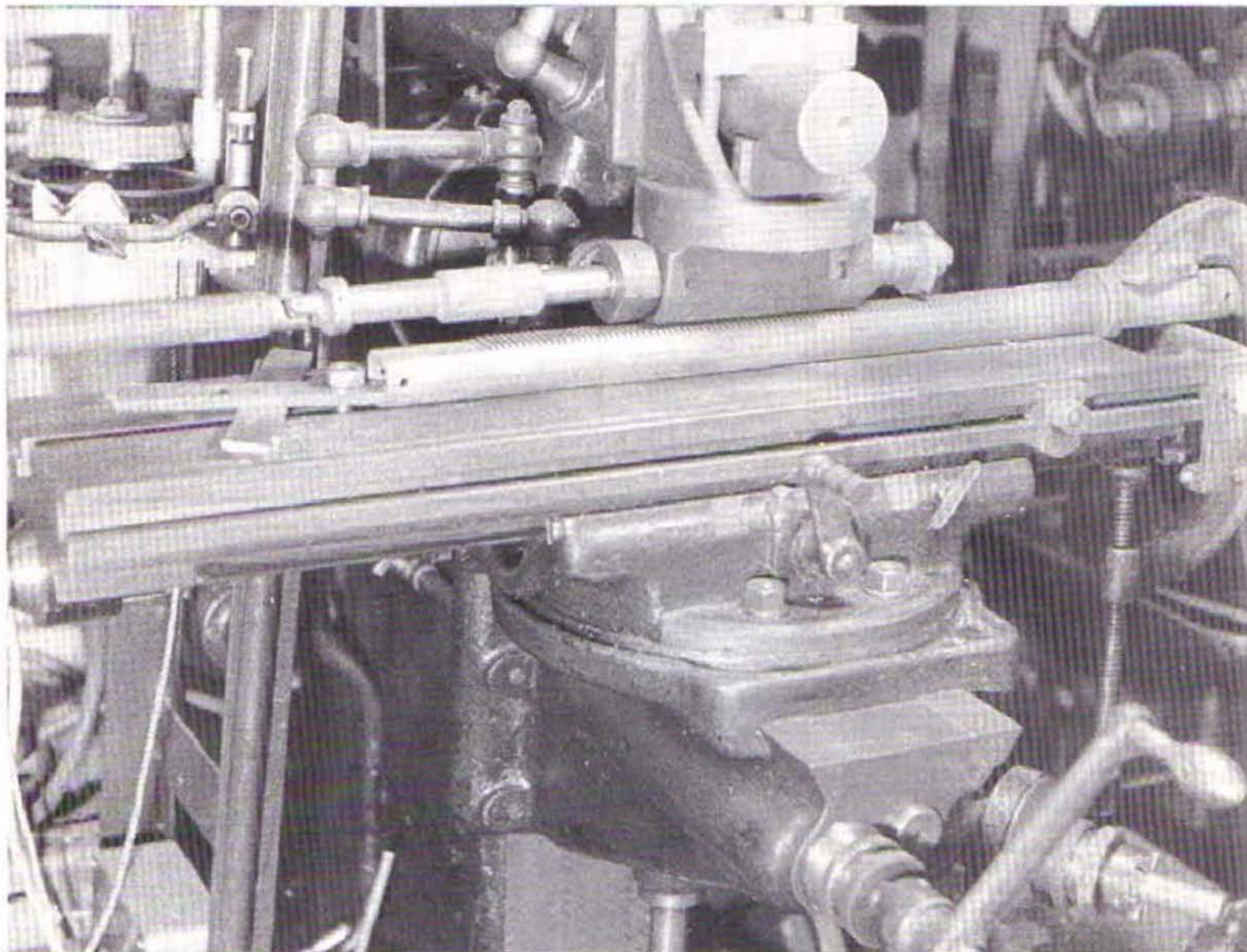
$$L \cdot \tan \frac{a}{2} = R \left(1 + \tan \frac{a}{2} \right)$$

$$R = \frac{L \times \tan \frac{a}{2}}{1 + \tan \frac{a}{2}}$$

AS D = 2R

$$\text{THEN } D = \frac{2L \times \tan \frac{a}{2}}{1 + \tan \frac{a}{2}}$$


This article is a first for M.E.W. in that following the design of the Taper Turning Attachment, it was check built from my drawings and text, by Mr. N. Smith of Bradford, Yorks. He also took the workshop photographs of the building of the attachment - Ed.



CUTTING RACKS

Following on from articles on making gear cutters and gears in recent issues, Don Unwin now gives some useful information on cutting racks

Cutting a short rack, either on the lathe using the vertical slide or on the milling machine is not particularly difficult, **Fig. 1**. In either case the longitudinal traverse is advanced by the amount of the circular pitch of the meshing gear each tooth. The circular pitch is calculated by

$$CP = \frac{\pi}{DP} \text{ in. or } \pi \times \text{metric}$$

module, mm. and the indexing proportion of a revolution of the lead screw given by

$$\frac{CP \text{ of Rack}}{\text{Pitch of screw}}$$

Don't forget to use the same units of measure! For example say a CP of 0.098 (32 DP) and a lead screw of 10 TPI or 0.1in

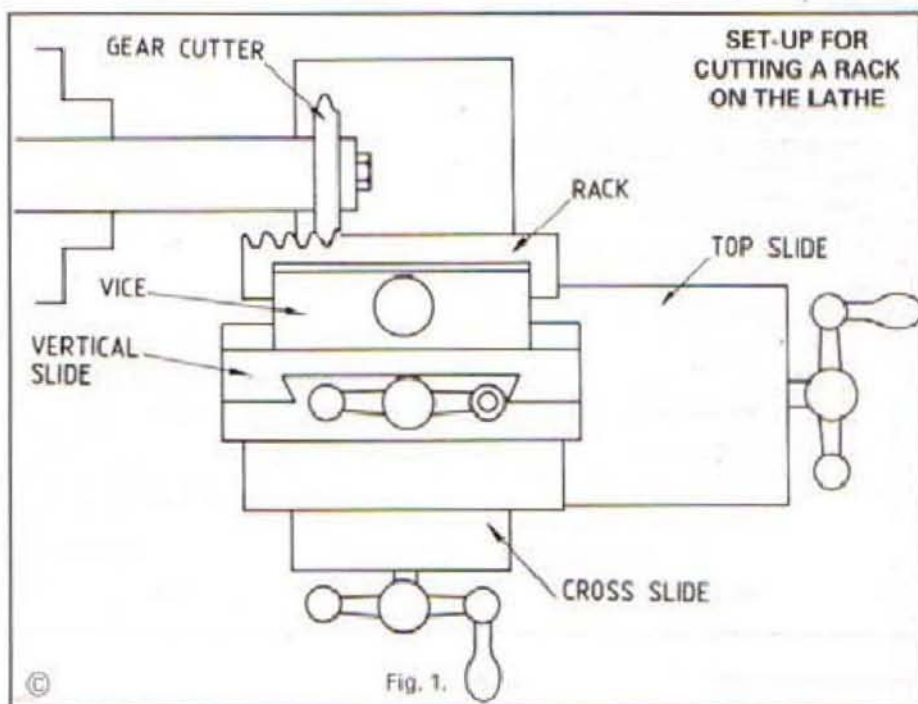


Fig. 1.

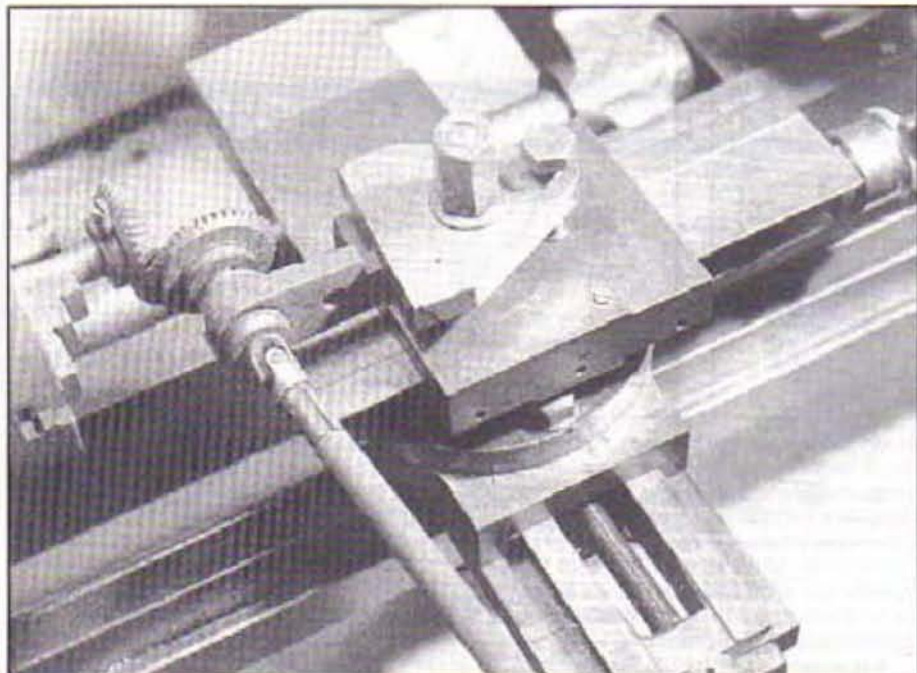


Fig. 3: The drive rig-up on the lathe.

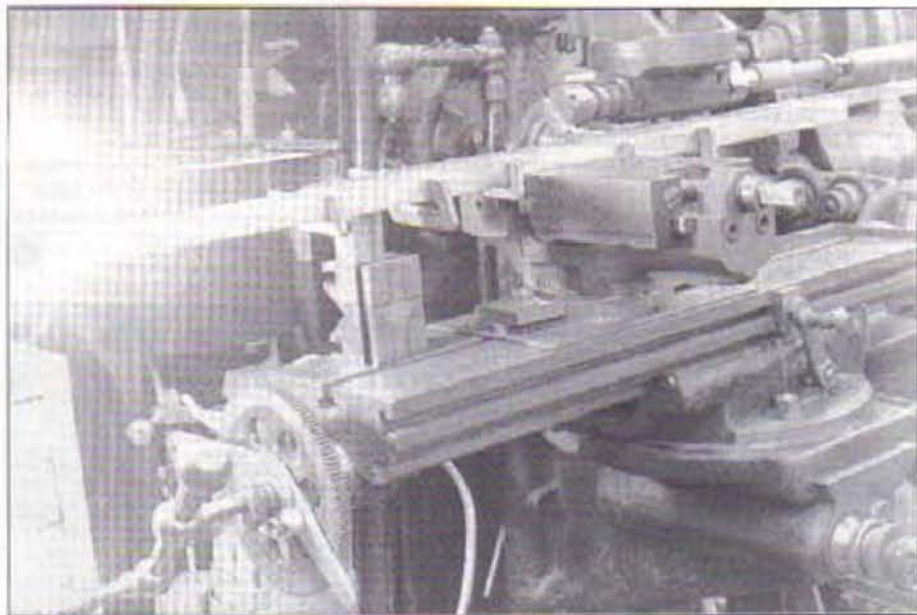


Fig. 4: Cutting the long rack strip set-up.

pitch the screw will need to be turned
 $\frac{0.098}{0.1} = 0.98$ of 1 revolution
 for each tooth.

On the lathe or the vertical or horizontal milling machine, the length that can be cut is limited by the length of the cutter arbor and the surrounding parts of the machine. However some time ago I needed to cut a much longer rack and this required a little more thought.

In common with many lathe users, I had a conventional milling spindle to fit on the saddle or vertical slide, driven by a belt from an overhead countershaft.

When I acquired my horizontal milling machine the spindle was adapted to fit on the overarm as a vertical head and driven by a belt from the countershaft.

The job was to cut 12in. of 1.5 module involute form rack teeth, on a flat machined on a piece of steel tube. The cutter I was going to use, was a No. 1, 135 to rack involute form 1 1/2in diameter, made as described in MEW Aug/Sep 1991 issue.

With the drive pulley removed, the milling spindle was mounted horizontally with the axis parallel and along the

machine table (Fig. 1). This was simple on the horizontal mill with the spindle clamped on the overarm, but on a vertical mill it would need to be clamped to the quill or the vertical slideways. The job was clamped longitudinally on the table and as the travel was only just sufficient the work had to be positioned so that, when mounted, the cutter would cover the portion required to be cut.

A change gearwheel and detent mounted on the end of the lead screw, provided the means of indexing the table travel. Using the relationship

$$\frac{CP}{\text{lead screw pitch}} \quad \text{I had } \frac{1.5\pi}{6.35} = 0.742$$

so I used 74 teeth on a 100 tooth gear which gives only a small error of 0.13mm or 0.005in. over the whole length, near enough. Fig. 2.

As there was insufficient clearance over the work for a drive pulley, some other form of drive had to be arranged. This was a rig-up of some junk universal joints and a piece of steel rod long enough to reach from the spindle to the nearby lathe. Some old bevel gears, one held in the lathe chuck, were arranged to get the drive in the correct direction. Fig. 3. To obtain the desirable 50ft. per minute cutting speed on steel using a carbon steel cutter 1 1/2in. diameter, we need a rotational speed of:-

$$\frac{\text{Required surface cutting speed}}{\text{Cutter diameter} \times \pi \text{ in same units}} = \text{RPM.}$$

$$\text{In my case } \frac{50 \times 12}{1.75 \times \pi} = 109 \text{ RPM}$$

so the lathe was set to approximately this speed.

The 'jury rig' worked like a charm, producing a very good rack indeed which ran smoothly with a 12 tooth pinion, cut with another home made 1.5 module cutter.

More recently I needed to cut teeth on the rim of a non-circular gearwheel for the replica medieval clock I am building. This wheel has a mean diameter of about 330 mm, cut with 331 teeth of 1 module, this time of ogival form.

The circular pitch is $1 \times \pi = 3.14\text{mm}$ and the total length $331 \times \pi = 1040\text{mm}$.

$$\text{Again using } \frac{CP}{\text{screw pitch}} \text{ we get } \frac{\pi}{6.35} = 0.4947$$

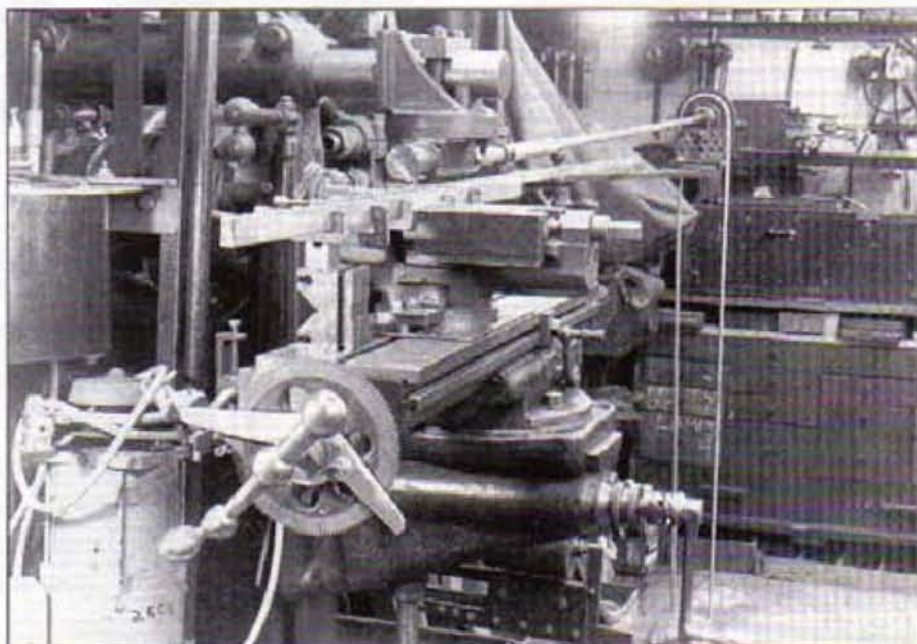
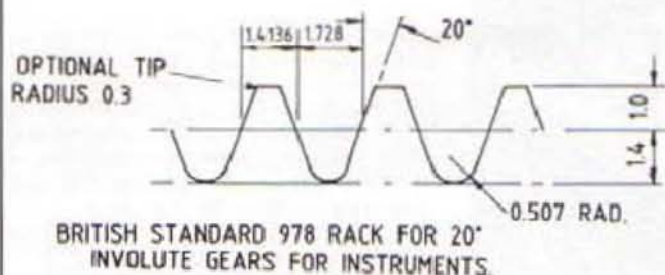


Fig. 5: The whole set-up for cutting the long rack.

FIG. 6.



THE BASIC INVOLUTE RACK FORM

turn per tooth. The nearest I could get was 63 teeth on the 172 gearwheel which equals 0.496 giving an error of 0.008mm per tooth, not enough to cause any problems.

As the material was brass I made a fly cutter using the dimensions given in the MEW article. The milling spindle was fitted up as before but this time, as the cutting speed could be much higher, a different drive was arranged. As before, the universal joint and long shaft were used, the outer end being supported in a bearing mounted via an angle plate and odd length of bar on the bed of the adjacent lathe. The shaft had a pulley fitted which was driven by a belt from an electric motor standing on the floor and held down by some weights.

An adjustable sector plate fitted to the indexing changewheel made the indexing of each tooth easy and reliable whilst the cross traverse was used to cut each tooth. As the length required was much longer than the machine table travel three 'bites' were going to be necessary.

A long piece of straight strip was supported on two equal height packings, upon which the rack strip rested being held by two thicker bars on either side, all being clamped together by the vice and a number of small G clamps. Fig. 4 shows this set-up. At each 'bite' the table was returned to the start, the strip unclamped, slid along until the last cut tooth is under the cutter, repositioning it by locating the cutter in the tooth and reclamping again. Fig. 5 shows the whole set-up with cutter, spindle, packings, clamps, indexing gearwheel, detent and sector arms, with the drive in the background.

After cutting the teeth the strip was carefully cut at the correct number of teeth, rolled to the required oval form and the joint hard soldered.

When cutting a rack with teeth of involute form some advantage can be taken of the shape to provide the necessary clearance for the cutter spindle. The basic involute rack tooth form has straight flanks angled at 20 deg. to the tooth centreline as in Fig. 6. If a cutter is made with one side flat and the other at an angle of 40 deg. to it, it can be mounted on an arbor in the cutter spindle which is angled at 20 deg. so providing the required clearance, shown diagrammatically in Fig. 7 and set up on my machine in Fig. 8.

To get sufficient clearance for the rather large body on my electric vertical head without too much arbor overhang I made the cutter 2½in. in diameter. To save material it is made from a strip of gauge plate forming a cross between a single tooth flycutter and a full circle multi-tooth cutter, a few teeth being made on each end of the strip. Nevertheless it works well on brass, light alloys and other similar

materials but is slow on steel. As the Browne & Sharpe circular arc cutter proportions given in Tables 1 and 1a of the Aug/Sept MEW are a compromise they are calculated on the smallest number of teeth in the cutter range so that cutter No 1, 135 to rack, has slightly curved flanks although to be absolutely correct the rack tooth should have straight flanks.

It is worth remembering that a screw thread can be used as a workable rack, the larger the diameter the better it is. Whilst a normal thread form will run with a gearwheel it is imperfect and only suitable for relatively crude mechanisms. A much more satisfactory result can be achieved by screwcutting with a 40 deg. tool of the correct proportions using a pitch equal to the required circular pitch. To obtain the changewheel train requires a little juggling with the teeth numbers.

$$\frac{\text{Drivers}}{\text{Driven}} = \frac{\text{Circular pitch}}{\text{Lead screw pitch.}}$$

For example a rack for

$$48 \text{ DP} = \frac{\pi}{48} \times \frac{1}{0.1} = \frac{0.654}{1.00}$$

Multiplying top and bottom by 100 gives 64.5,

100, say 64 driver 100 driven would be satisfactory. Another approach is to start with a pitch you can cut and match a DP or module to it. If we choose ½in. BSF, 16TPI, the pitch is 0.0625in. Given that $\text{DP} = \frac{\pi}{\text{CP}}$

we have $\frac{\pi}{0.0625} = 50.26$ or near enough 50 DP.

By soft soldering a piece of strip of the required size on to the circumference of a large diameter piece of tube or rod the rack can be screwcut then unsoldered, Fig. 9. The larger the diameter of the rod the flatter will be the produced rack.

As the teeth on a rack produced in this way are at a slight angle due to the helix angle of the thread the gear face should be narrow or alternatively cut at a similar angle.

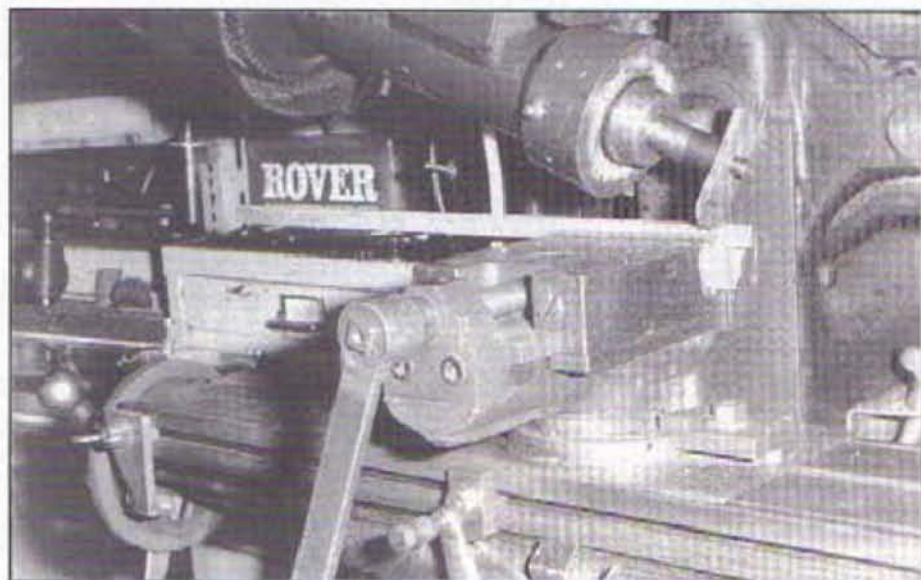


Fig. 8: The set-up on the milling machine.

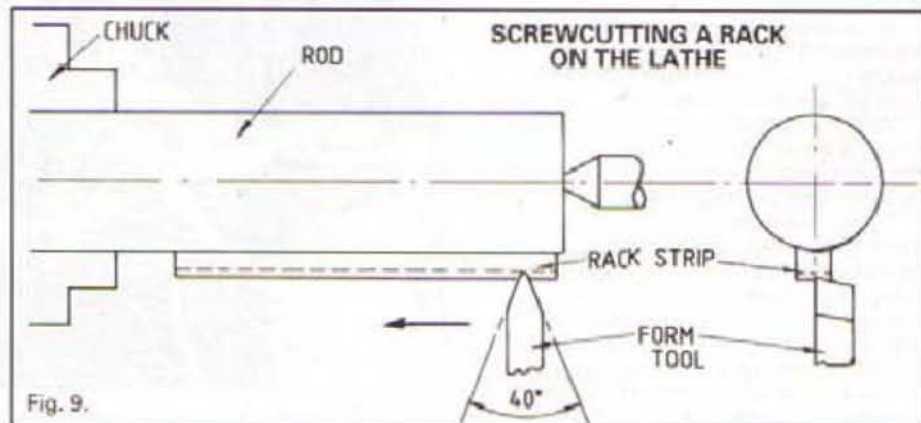


Fig. 9.

MODEL ENGINEERS' WORKSHOP INDEX

We have arranged this index so that it can be removed from the magazine without damage to the rest of the contents, if you so desire. Cut down the dotted line. We suggest that you store the index in a transparent bag, for handy reference

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